

# cpu

COMPUTER POWER USER



**WHITE LIGHTNING**  
ANTHONY LACKEY STRIKES TWICE

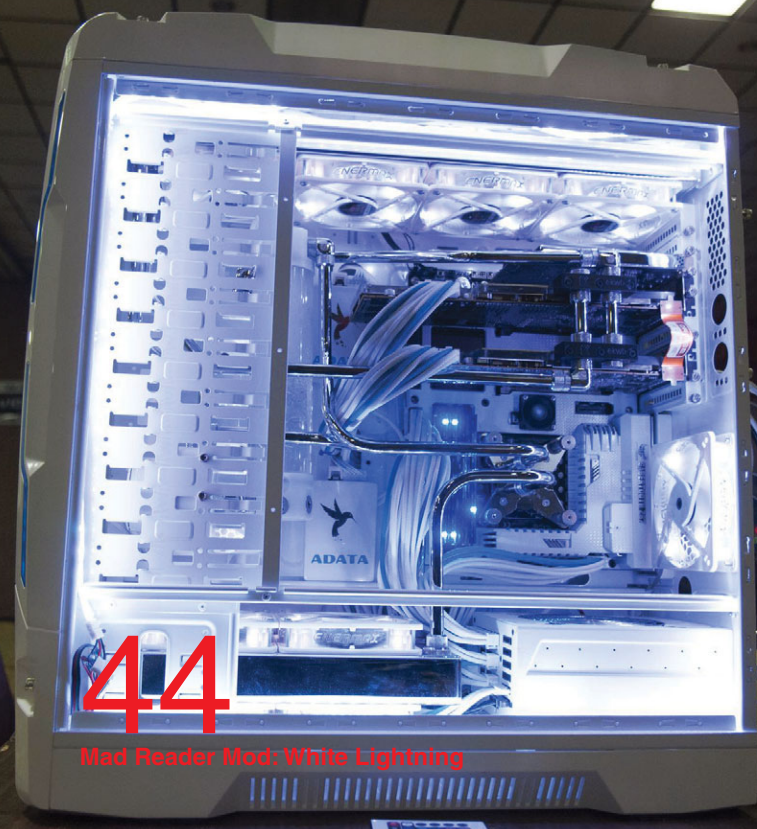
**PNY**

## XLR8™ CS2111 SSD

IGNITE YOUR PASSION







**FRONTSIDE — P. 3**

News, product release information, and stats from the tech industry.

**HEAVY GEAR — P. 12**

The latest PC hardware is here: reviews, product profiles, and category roundups.

**CPU SYSTEM WORKSHOP — P. 27**

Our 16th system build is on its way to PAX East in Boston, where we will be giving it away. Check it out here first!

**HARD HAT AREA — P. 44**

CPU's Mad Reader Mod winner, LAN party coverage, and in-depth looks at the latest technology.

**LOADING ZONE — P. 69**

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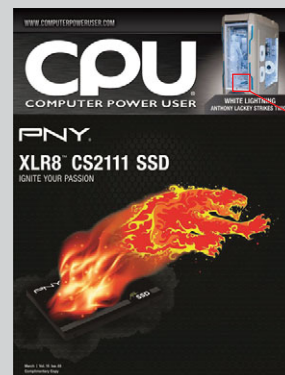
**DIGITAL LIVING — P. 76**

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Monthly last-page interview with people who help to shape the PC industry.

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## GIGABYTE Updates BRIX Models With Intel's New Broadwell CPUs

Ultra-compact form factor PCs have become increasingly popular in recent years, in part because of attractive case designs such as those employed by the BRIX system lines from GIGABYTE. The company recently began updating its BRIX barebones systems to include Intel's Broadwell family of CPUs. The new GB-BXi7H-5500 comes with the 14nm dual-core 2.4GHz i7-5500U processor and is in the BRIX s family, so it supports both a 2.5-inch SATA 6Gbps drive slot and an mSATA port. (The choice of storage type is up to the user, as is the DRAM and the operating system.) The unit includes Intel HD Graphics 5500 and it supports dual displays. It also comes with Gigabit LAN and support for 802.11ac (in the U.S., the unit comes with a Dual Band WiFi/Bluetooth 4.0 module). GIGABYTE's BRIX systems are available in various configurations and price points; MSRP for the barebones BRIX GB-BXi7H-5500 starts around \$509.

## Get Max Power At Max Efficiency With EVGA's SuperNOVA 1600 T2

The 80 Plus ratings you see on power supply units are a way of indicating how efficient PSUs are at various load levels. The ratings start at 80 Plus and then advance through Bronze, Silver, Gold, and Platinum levels, with 80 Plus Titanium being the highest level a PSU can reach. EVGA's recently released SuperNOVA 1600 T2 reaches rarefied heights indeed, as it offers a huge 1600-watt capacity at the 80 Plus Titanium level, which means it has 94% or better efficiency under a 50% load. (EVGA also has G2, for Gold, and P2, for Platinum, 1600-watt models in the same line.) The SuperNOVA 1600 T2 is fully modular and comes with a 140mm, double-ball bearing fan and EVGA's Intelligent Thermal Control Fan system to minimize noise. The T2 measures 3.4 x 5.9 x 7.9 inches (HxWxD), weighs 8 pounds, and comes with a 10-year limited warranty. MSRP is \$449.99.



### WATCHING THE CHIPS FALL

Here is the pricing information for various AMD and Intel CPUs.

CPU	Released	Original Price	Last Month's Price	Online Retail Price*
AMD FX-9590 Eight-Core	6/11/2013	N/A	\$239.99	\$239.99
AMD FX-9370 Eight-Core	6/11/2013	\$375	\$204.99	\$219.99
AMD FX-8350 Eight-Core	10/23/2012	\$195	\$179.99	\$179.99
AMD FX-8320 Eight-Core	10/23/2012	\$169	\$149.99	\$149.99
AMD FX-6350 Six-Core	4/30/2013	\$132	\$124.99	\$125.99
AMD A10-7850K Quad-Core	1/14/2014	\$173	\$159.99	\$149.99
AMD A10-7800 Quad-Core	7/2/2014	\$153	\$141.99	\$141.99
AMD A10-7700K Quad-Core	1/14/2014	\$152	\$129.99	\$129.99
AMD A10-6800K Quad-Core	6/4/2013	\$142**	\$129.99	\$129.99
AMD A10-5800K Quad-Core	10/2/2012	\$122**	\$99.99	\$99.99
Intel Core i7- 5960X Eight-Core	8/29/2014	\$999**	\$1,049.99	\$1,049.99
Intel Core i7- 4960X Six-Core	9/3/2013	\$990**	\$1,025.99	\$1,025.99
Intel Core i7- 5930K Six-Core	8/29/2014	\$583**	\$579.99	\$579.99
Intel Core i7- 4930K Six-Core	9/3/2013	\$583**	\$579.99	\$579.99
Intel Core i7- 5820K Six-Core	8/29/2014	\$389**	\$389.99	\$389.99
Intel Core i7-4790K Quad-Core	6/25/2014	\$339**	\$339.99	\$319.99
Intel Core i7-4770K Quad-Core	6/2/2013	\$339**	\$344.99	\$349.99
Intel Core i7-4820K Quad-Core	9/3/2013	\$323**	\$322.99	\$319.99
Intel Core i7-4790 Quad-Core	5/11/2014	\$303**	\$309.99	\$304.99
Intel Core i5-4690K Quad-Core	6/3/2014	\$242**	\$239.99	\$234.99

\* As of February 2015

\*\* Manufacturer's estimated price per 1,000



## MSI Celebrates Selling 100 Million NVIDIA GPU Cards With Two Releases

MSI recently announced it had reached an historic milestone by selling 100 million graphics cards carrying NVIDIA GPUs. To celebrate, the company is releasing two new versions of its GTX 960 Gaming and GTX 970 Gaming models. The new cards feature a special color scheme that pays homage to Team Green, as well as MSI's Twin Frozr V cooler, the company's dual-fan cooling system that manages to squeeze the heatsink and two 10cm Torx fans into a less-than-dual-slot space. MSI says it also will include a "special gift" to show its appreciation with each purchase.



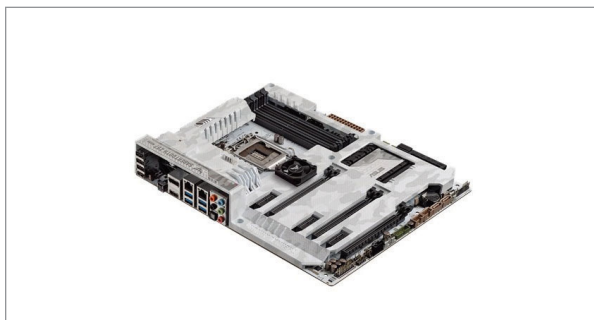
## Pebble Returns To Kickstarter To Launch A New Watch: Pebble Time

There are many smart watch companies around, but Pebble was one of the first to create a successful product. Three years after raising over \$10 million to launch the original Pebble watch, the company has returned to Kickstarter to announce a new product, Pebble Time. The watch has a new interface that shows communications and appointments chronologically instead of in separate apps. Pebble Time is backwardly compatible with all existing apps, too. Evidently people like the concept, as the Kickstarter for Pebble Time was funded multiple times over within a few hours.



## ASUS Puts On The Ritz For Limited-Edition Sabertooth Z97 Mark S

Fashionistas know the only thing that tops a black tie event is a white tie event. ASUS must be feeling the spring fashion season coming on, as it has released the all-white limited-edition Sabertooth Z97 Mark S motherboard. Clothed in Arctic Camo Thermal Armor that cools and protects components, white Dust Defenders that protect ports and slots, and ASUS' Arctic Camo TUF Fortifier (which includes a reinforced backplate and thermal pad that can reduce operating temps by 7 degrees C), the Sabertooth Z97 is dressed to kill in white. You'll find these individually numbered boards at retail for around \$300.



## Get 7.1 Virtual Surround Sound Via Hardware With HyperX Cloud II

Kingston Technology says its new HyperX Cloud II headset delivers 7.1 virtual surround sound without users needing to download any drivers, as the effect is hardware-based. Thanks to a newly designed USB sound card audio control box that has independent volume controls for audio and microphone, gamers just need to toggle a switch to enjoy the benefits of 7.1 surround sound. The microphone is optimized for TeamSpeak as well as Skype. The HyperX Cloud II is now available in Gun Metal and Red, and a limited-edition pink version is coming soon. The headset retails for about \$100.





## Chill With Corsair's H100i GTX AIO Cooler & Crank Up Your CPU

Corsair's new H100i GTX CPU cooler is an entirely self-contained unit that comes prefilled with coolant and never needs refilling, so you won't have to mess with any liquids, period. The unit has a 240mm radiator that mounts into cases with dual 120mm fan mounts. The waterblock comes with a magnetic multi-platform mounting kit that is compatible with modern Intel and AMD sockets. Attach the Corsair Link cable to a USB header and you can use Corsair's free Dashboard software to adjust fans speeds and monitor various system temps. The H100i GTX retails for \$119.99.



## ASRock's New VisionX 471D Packs A Desktop's Power Into An HTPC

The HTPC field is getting a powerful new entry thanks to ASRock's VisionX 471D. The system manages to pack an Intel Core i7 4712 mobile Haswell, 8GB of DDR3, a Radeon R9 M270X graphics card, 2TB of HD storage, and another 256GB of SSD space into a form factor that's less than 8 inches square and 2.76 inches high. ASRock says that despite the powerful components, the system only sips 24 watts of power while idle, plus it boots into Windows 8 in half the time of its predecessor, with VisionX 420D. The VisionX 471D is expected to retail for under \$999.



## Antec Offers New P380, A Top-Of-The-Line Aluminum Full-Tower Case

Antec is coming out with a new high-end full-tower case for its Performance One line called the P380. The case is designed for tool-less installation and is built to accommodate liquid-cooling setups. The front and top bezel are aluminum, and you can swap side panels and the top I/O panel to make it more convenient to have the computer on your right or left side. Antec has removed all 5.25-inch bays; instead, you'll find eight 3.5/2.5-inch bays and one slim optical drive bay. With nine expansion slots, this 21.85 x 8.8 x 21.92 (HxWxD in inches) case has plenty of building room. MSRP is \$229.95.



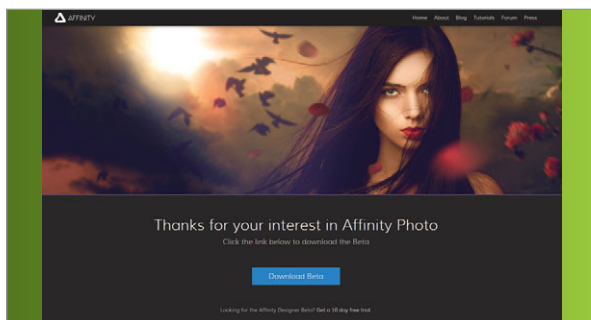
## New POSEIDON Z Forged Model Joins Tt eSPORTS' Keyboard Line

Tt eSPORTS is coming out with a new version of its POSEIDON Z gaming keyboard. The new model, called POSEIDON Z Forged, offers the same Tt eSPORTS Certified Mechanical Blue and Brown keyswitches, but adds an aluminum faceplate. The 104-key backlit keyboard has five lighting zones and brightness levels and handles up to 100 programmable key macros. As with other models in the POSEIDON series, Tt eSPORTS offers a 5-year warranty on the new Forged. The POSEIDON Z Forged mechanical gaming keyboard should be arriving at retail any time. MSRP is \$139.99.



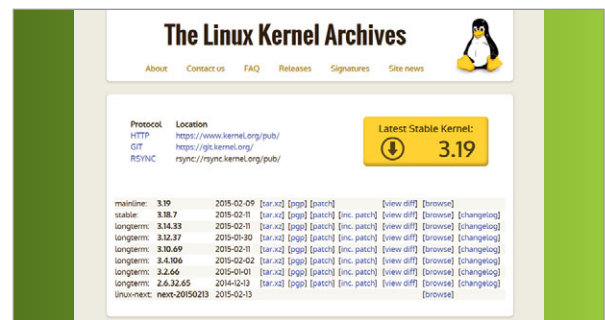
## Serif Gives Photo Pros A Powerful New Editing Choice: Affinity Photo

Serif, the software maker that specializes in publishing and graphics software that's powerful but affordable, has come out with a new photo-editing product called Affinity Photo that offers some amazing effects. The software lets you quickly remove unwanted objects from a scene, change the direction of a light source in your photo, erase facial blemishes from a subject, and add or merge images. You can experiment with special art effects such as melting and reshaping an object in a photo. The software is for Mac users only; you can download the free beta from [affinity.serif.com](http://affinity.serif.com).



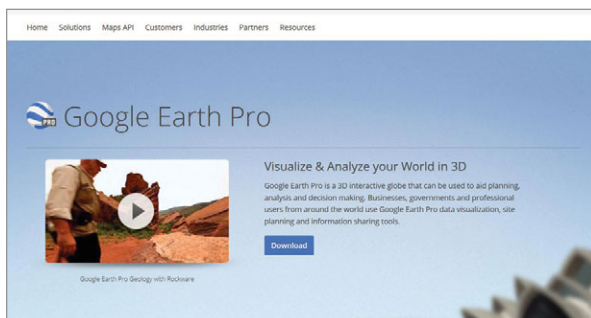
## Linux Kernel Version 3.19 Officially Released; Work Starts On Ver. 3.20

Linux creator and guiding light Linus Torvalds announced the release of version 3.19 of the Linux Kernel recently, saying on his blog (hosted by the University of Indiana) that he could see no reason to delay the release any further. According to KernelNewbies.org, the latest release of the OS supports fast device replacement for devices in RAID 5 and 6, supports Intel's MPE (Memory Protection Extensions), includes HSA (Heterogenous System Architecture) support for Radeon GPUs, and moves the Android binder out of the kernel's staging area, among other things.



## Google Changes Direction: Now Anyone Can Use Earth Pro For Free

Google has decided to make the Professional version of Google Earth available for free for both business and personal use. The program was previously available for an annual fee of \$399. Google Earth Pro is a more powerful version of the original Google Earth program; it provides more statistical information about locations and allows you to view buildings in 3D. Where Google Earth allowed users to import just one address at a time, Earth Pro supports bulk imports of up to 2,500 addresses at a time. You also can print at much higher resolutions, as well as output video from the program in HD.



## Microsoft Says Upcoming Windows Version Will Support Raspberry Pi 2

Looks like the momentum for Raspberry Pi is growing. Microsoft has announced Windows 10 will support Raspberry Pi 2, and that it will make the ecosystem of Windows development tools available to the Pi community for free through its Windows Developer Program For IoT. The announcements were made by the General Manager of the Windows IoT Group, Kevin Dallas, via the company's Windows Apps blog. Dallas said Microsoft is embracing the maker movement and the Raspberry Pi platform, and that the company has big plans for Windows 10 and the IoT.





## Valentine's? No, Internet Safety Day

Internet Safety Day is an annual event celebrated by more than 100 countries on the second Tuesday in February. Originally started by groups in Europe, the event promotes safe Internet use among the world's youth. In the U.S., the host of the event is the American non-profit [ConnectSafely.org](http://ConnectSafely.org). This year the organization celebrated Internet Safety Day with panel discussions for youths and tech industry leaders held on Facebook's campus in Menlo Park, Calif. ConnectSafely also encouraged people to continue sending their stories to [OneGoodThing.org](http://OneGoodThing.org), a campaign started for Internet Safety Day last year that asks people to share what they are doing to make the world a better place.



## U.S. Responds To Growing Threats, Creates New Cybersecurity Unit

To face what it sees as a growing threat to national security, the U.S. government has established a new security agency: the CyberThreat Intelligence Integration Center, or CTIIC. While several existing agencies are already involved in one way or another with cybersecurity, administration officials say gaps exist in communications among the various institutions. The CTIIC will be charged with pooling information from, and disseminating information to, other U.S. intelligence agencies as well as civilian institutions about cyberbreaches and related security threats.



## New Browser For Power Users From The Former CEO Of Opera

There's a new browser option for people who want a lot of control over how they use the web. Vivaldi is a browser now out in beta that is being created by a team of 25 people that includes some former key members of the team that created Opera. Vivaldi CEO and cofounder Jon von Tetzchner, for example, also was the cofounder and former CEO of Opera. The new browser's web site says this first build is a "technical preview" of where the browser is heading, and that the team is working on a number of features, including spatial navigation (using just your keyboard) and email. Stay tuned.



## Life & Times At ESnet: The World's Fastest Science Network (100Gbps)

Sure, maybe you have the fastest home network in your building; maybe on the whole block. But whatever you may be running at home (or work), it pales compared to what the folks at ESnet (Energy Sciences Network) are doing. Their network is 15,000 times faster than the average home network, which it better be, because they move 20 petabytes of scientific data each month. Someday, the technology used by the institutions on ESnet will likely be used by the rest of us, but until that happens, you can read up on the network at the website ([es.net](http://es.net)) and dream "if only" stories.





## Job Of The Month

Symantec, a company that makes an extensive range of backup and security products for consumers as well as companies of all sizes, is looking for some top-notch programmers to design and build web products and services for its Cloud Platform Engineering group. The full-time positions open in the group include one for Senior Software Engineer. The ideal candidate for this position will have at least a B.S. in computer science and have extensive experience working with C++, Python, and Java, as well as open-source tech such as Kafka and Zookeeper. It's a huge plus if you have a strong knowledge of large-scale distributed system frameworks, NoSQL technologies, and big databases. You should be a fan of the test-driven development process and be familiar with Agile as well. Slackers need not apply: Symantec wants people who are motivated and "have a low tolerance for mediocrity." The person getting this position will work out of Symantec's world headquarters in Mountain View, Calif.

Source: Symantec

## Households Willing To Pay For Smart Services

Research by Park Associates has shown that households with broadband access are interested in several categories of services that are starting to emerge as the IoT begins to take shape. The research firm said survey recipients indicated they are most interested in an HVAC monitoring service, followed by an energy monitoring service and appliance monitoring. The number of people showing an interest increases when services are bundled together. Researchers said more than 50% of the survey participants indicated they would be willing to pay \$2.99 monthly for a bundle of all three service types. (Are you listening, service providers?) Park Associates was scheduled to share additional insights from its research at a Smart Energy Summit held at the Four Seasons hotel in Austin, Texas in late February.

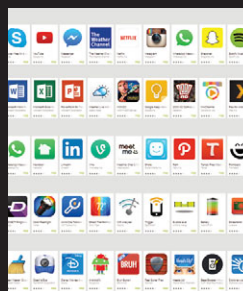
Source: Park Associates

### Percentage Of U.S. Households With Broadband Who Are Interested In An:

Appliance Monitoring Service	22%
Energy Monitoring Service	25%
HVAC Monitoring Service	26%

## Phone Users Are App-Happy, But They're Also Cheap

People on the go like to use apps—especially when the programs are free. A recent eMarketer survey of mobile device users in the U.S. revealed that while 90% of tablet users intend to download and install at least one app this year, only 44% actually would buy an app. The intend-to-purchase numbers are even worse for the smartphone crowd. While 93% of smartphone users say they will download and install apps this year, only 36% said they would pay for an app. Findings show that consumer preference for free apps is actually increasing, and eMarketer expects the trend will continue over the next few years. Overall, about 80.1 million consumers in the U.S., or one-third of mobile device users in the country, will buy at least one app during the year.



	Will Download & Install Apps	Will Buy Apps
U.S. Tablet Users	90%	44%
U.S. Smartphone Users	93%	36%

Source: eMarketer

## RAW Numbers:

2

Number of hours that the average mobile gamer spends playing games on portable devices (phones/tablets/iPods) each day. This is up 57% from the amount of time these users spent gaming on their mobile products in 2012.

NPD Group

37%

Percentage of broadband households in the U.S. that indicate they will purchase some type of smart device this year.

Park Associates

1.5 billion

Number of smart payment cards (payment cards with chip/pin number capabilities) that shipped globally during 2014. Of this total, approximately 40% were "contactless" (tap-and-go) cards. About 180 million smart cards, or 12% of the global total, shipped in the U.S.

Smart Payment Association

7.1 billion

Number of minutes of sports content that Americans consumed via their smartphones during the third quarter of 2014. More than 72 million people in the U.S. viewed some sort of sports content on their phones during those three months.

Nielsen





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# PNY XLR8 CS2111

## Make Life Simple



What's the best way to make your life simple? If you're a PC enthusiast (a gamer, a builder, a modder, a content creator, and so on), simplicity is most quickly achieved by finding the right blend of components to make your PC as responsive and fast as it can be. It stands to reason that if your computer starts up faster, loads apps and games more quickly, tears through large file transfers with aplomb, and generally makes you wait less, you will at least have one less thing to concern yourself with, whether you're at work or at play.

That's where PNY's XLR8 brand of enthusiast components comes in, and in particular the latest addition to the company's lineup of XLR8 solid-state drives, the XLR8 CS2111. At first glance, this SSD seems a bit of a departure for PNY, whose SSD exteriors up to now have been fairly conservative by comparison. The flaming tiger leaping across its surface suggests that this drive may be dramatically faster than previous XLR8 drives, and PNY Senior VP of Storage Solutions Vinny Girardi, Sr., says such an assumption is well founded.

"The new CS2111 XLR8 SSD provides up to a 30% increase in sequential read performance, which is a critical metric for read-intensive gaming applications," Girardi says. "These performance gains are consistent across any data pattern, whether you're transferring pre-compressed files, such as video and pictures, or compressible data files typical of most office documents."

### The Flaming Claws Meet The Road

Why are these drives so fast? PNY's MLC (multi-level cell) NAND flash

*Advertisement*



memory is part of the equation, certainly. In addition, Girardi says, the CS2111's Silicon Motion SM2246EN controller and firmware play a large role in its performance.

"We chose SMI because they have the right controller performance to meet the segment's needs. PNY has a strong relationship with SMI and we work closely with SMI's engineering team to help optimize the firmware on our drives."

In addition to the usual suspects (NAND flash, controller, and firmware), PNY's internal process plays a significant role in the SSDs' performance, as well.

"PNY has extensive validation, test, and quality requirements to ensure that you receive the best gaming

SSDs that PNY can offer, which go beyond the typical consumer product specifications," says Girardi.

The results are impressive indeed. The drive turns in sequential max reads and writes of 560MBps and 455MBps, respectively, as well as random reads and writes up to 71,000 IOPS and 75,000 IOPS. The CS2111 comes with a 2-year warranty that you can quickly double to four years if you register your drive within 90 days of purchase.

### Options, XLR8ed

At launch, PNY offered the XLR8 CS2111 SSDs in 240GB and 480GB sizes, and Girardi tells us a bigger drive is in the works: "We are currently validating a 960GB drive. We expect to

see this capacity hit the shelves in early Q2 of 2015."

Girardi also tells us that PNY's engineering team is experimenting with CS2111 M.2 prototypes; an announcement may be forthcoming soon. In addition, Girardi points out that these blazing-fast SSDs are just one part of the XLR8 ecosystem.

"PNY is in a unique position to be able to offer a portfolio of solutions including graphics, memory, and storage," he says. "When combined, the XLR8 portfolio provides enhanced performance in order to meet the demanding requirements of the gaming industry. No other company can match the breadth of products optimized for the gaming community." ■



**Silent Base 800**

\$139.90

be quiet!

[www.bequiet.com](http://www.bequiet.com)

## be quiet! Silent Base 800

Up until recently, our experience with be quiet! products was limited primarily to the company's power supplies, CPU coolers, and case fans. In all of these cases, spending time with be quiet! gear yielded favorable impressions; we saw products that represented meticulous design, first-class manufacturing, and an attention to detail that rivals that of any company whose products we have reviewed. Because of this, we were guardedly optimistic going into our review of the be quiet! Silent Base 800, and we are happy to report that we have not been disappointed.

The Silent Base 800 is a primarily black full-tower case constructed of 0.7mm-thick steel and ABS plastic that is available with trim accents in black, silver, or orange. We received the silver variety for this review, so the case has a silver accent that runs around the vertical mesh vents on either side of the front panel (these are shaped more like automotive air intakes than case vents), as well as silver feet/stands that quickly snap into place when you first unpack the case.

In a time when PC cases are designed with increasingly flexible interiors, the Silent Base 800 goes further toward builder friendliness than just about any case we've seen to date; not only can you remove the 5.25-inch drive cage up top if you want to, but you can also remove either or both of the 3.5-inch drive cages below it (one holds three drives, the other four) and replace the 5.25-inch cage with one of the lower cages if that's what works best for you. In addition, you can invert either of the 3.5-inch cages and mount an SSD or 2.5-inch HDD on top of the cage, and there are two additional 2.5-inch drive mounts on the back surface of the motherboard tray.

Tool-less 5.25-inch drive installation, ample cable management slots (with silicone rubber grommets), and a massive cutout for CPU cooler installation are, of course, in place. be quiet! pre-installs three of its excellent Pure Wings 2 fans in the Silent Base 800, including two 140mm units behind the front panel and a 120mm

fan in the rear. Should you find the need, you can add a pair of 140mm or 120mm fans beneath the top panel, another on the bottom, and/or a 120mm fan behind the left side panel. There are removable dust filters behind the front panel and beneath the power supply mount, and you can remove pretty much any panel and strip the case down to its frame with ease. If you find that the upper front door opening to the left doesn't work for you, you can fairly quickly reconfigure it to open to the right.

The Silent Base 800 is dominated by smooth, flat surfaces but has just enough sculpting here and there to give it a unique blend of the understated look and feel that we've seen from other European manufacturers and a touch of boldness that some mainstream cases go overboard on. The result is a case that looks great in its stock configuration and is highly functional, and that we would guess will be a hit in the modding community, as well. ■

BY CHRIS TRUMBLE

**Specs:** Dimensions: 22 x 10.5 x 19.5 inches (HxWxD); Materials: Steel, ABS plastic; Motherboard support: microATX, Mini-ITX, ATX; Drive bays: 3 x 5.25-inch external, 7 x 3.5-inch internal, 4 x 2.5-inch internal; Fans (included): 2 x 140mm front, 1 x 120mm rear; Fans (optional): 2 x 120mm/140mm top, 1 x 120mm/140mm bottom, 1. 120mm side; Ports: 2 x USB 3.0, 2 x USB 2.0, audio I/O





**msi**

MSI recommends Windows.

**GS30 Shadow**  
with GamingDock

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## ENERMAX LIQMAX II 240

We live in an age of sequels and remakes. Sometimes, sequels are even better than the original (“Aliens,” “The Dark Knight,” and “The Empire Strikes Back,” to name a few), while other times, “new” isn’t always “improved” (cough, cough, the “Fast & Furious” franchise). We’re glad to say that ENERMAX’s LIQMAX II series improves upon the original.

The LIQMAX II lineup currently consists of 120mm radiator and 240mm radiator models. These closed-loop coolers also feature new fans (model UCBS 12P) with ENERMAX’s Double Batwing blades that maintain a continuous burst of air—ideal for dissipating heat from the radiators. We got a chance to check out the LIQMAX II 240 and find out how it handled tough thermal loads.

There’s a lot of impressive technology inside of the LIQMAX II 240’s waterblock. It all starts with ENERMAX’s SCT (Shunt Channel Technology) that redistributes

coolant flow over multiple channels to accelerate heat transfer and reduce hot spots. ENERMAX further bolsters the waterblock with impellers that increase both pump pressure and flow momentum. ENERMAX rates the pump’s motor speed at a powerful 2,700rpm, whereas ENERMAX’s first-generation closed-loop cooler’s pump motor ran at 2,500rpm.

ENERMAX includes two 120mm PWM fans with the LIQMAX II 240. Both fans feature ENERMAX’s smart APS (Adjustable Peak Speed) switch that lets you select from three RPM settings (1,200rpm, 1,600rpm, and 2,000rpm). The lower the fan speed, of course, the lower the noise. Rated airflow and noise levels for the three peak speeds are as follows: 58.3cfm/23dBA at 1,200rpm, 75.5cfm/30dBA at 1,600rpm, and 96cfm/35dBA at 2,000rpm. The fans’ PWM control lets it spin as slow as 500rpm when the PC is idle, and it will ramp up to the selected APS mode under load.

As mentioned, the Double Batwing blades are ideal for moving a lot of air through radiators. The Double Batwing blade design is especially effective at lower fan speeds, according to ENERMAX. At 1,200rpm, for example, the Double Batwing blade delivers a static pressure of 1.3mm/H<sub>2</sub>O, a 20% improvement over ENERMAX’s Cluster Advance fan. At the maximum 2,000rpm speed, ENERMAX rates the fan’s static pressure at 3mm/H<sub>2</sub>O.

In terms of appearance, black is the dominant color on the LIQMAX II 240. The waterblock/pump combo unit has grey accents and an LED-lit ENERMAX logo, adding a bit of visual pop. ENERMAX uses a universal backplate that supports all current Intel and AMD processors.

To test the LIQMAX II 240, we used Core Temp to monitor temperatures at idle and under load. We switched the fans’ APS mode to the 2,000rpm setting for maximum performance. At idle, Intel’s Core i7-4790K (running at stock clocks) ran at a maximum temperature of 28 degrees Celsius. Next, we ran POV-Ray 3.7 on all cores for 10 minutes, resulting in a maximum temperature of 79 C. Finally, we ran Prime95’s (version 28.5) Small FFT test on all cores and threads. This demanding test pushed the CPU’s maximum temperature to 95 C.

With all of the refinements ENERMAX made to the LIQMAX II 240, the cooler is anything but a sophomore slump. We particularly liked the Adjustable Peak Speed fans with the Double Batwing blade design. The excellent static pressure at lower fan speeds is ideal for builders that want minimal noise from a closed-loop cooler. ■

BY NATHAN LAKE

### LIQMAX II 240

\$99.99

ENERMAX

[www.enermaxusa.com](http://www.enermaxusa.com)

**Specs:** Materials: Copper (waterblock), aluminum (radiator); Socket compatibility: Intel LGA 775/1150/1155/1156/1366/2011, AMD AM2/AM2+/AM3/AM3+/FM1/FM2/FM2+; Pump: 2,700rpm, 12V; Fans: 2 120mm PWM with (500 to 1200/1600/2000); Radiator dimensions: 27mm x 274mm x 120mm (HxWxD); Warranty: 2 years

**Test system specs:** Processor: Intel Core i7-4790K; Motherboard: GIGABYTE GA-Z97X-GAMING 5; GPU: PNY GeForce GTX 780 XLR8 Overclocked Series; Memory: 8GB ADATA XPG V3 DDR3-2400; Storage: 128GB Crucial RealSSD C300; OS: Windows 8.1 Enterprise (64-bit)

## Q&A With ENERMAX's Jack Sung

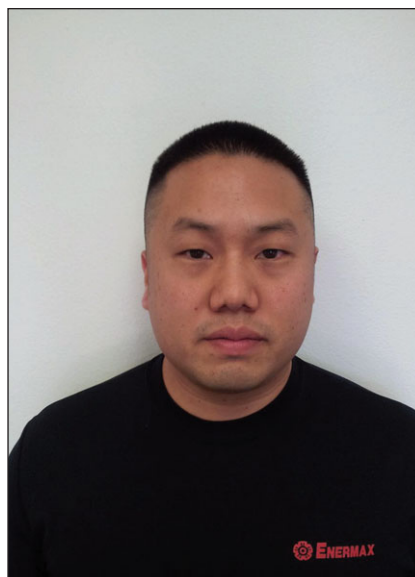
### North American Marketing Manager Talks New Products

**Q** : ENERMAX showed off some pretty interesting products last month at CES. Can you tell readers about your lineup for those who haven't heard?

**JS** : We showcased many different product lines at CES, and a few of them that we would like to mention to you and the readers include the Thormax GT full-tower case that supports E-ATX motherboards and variations of liquid-cooler support up to 360mm. In addition, we've also announced the ENERMAX 1250W 80 PLUS Titanium power supply. It will be 96% efficient at 50% load. This PSU will come with exclusive features that will allow users to adjust OCP (overcurrent protection) tolerance and switch between single-rail and multi-rail so that users can achieve the best performance for their builds.

**Q** : Let's talk a little bit about the new power supply first. Titanium efficiency is a pretty big deal, especially when you're discussing wattages as high as 1,250 watts. But the feature that is even more interesting is the new unit's ability to switch between single- and multi-rail operation modes. How exactly does this work?

**JS** : ENERMAX's 1250W 80 PLUS Titanium PSU will come with exclusive monitoring and control software that allows users to switch the PSU between single-rail and multi-rail. For example, when this 1,250-watt PSU is set up with dual +12V rails, the OCP can be set to 55 to 65 amps per rail; however, the OCP can be changed to 105 to 115 amps in single-rail



mode. This feature is important, as there are only a limited number of single-rail PSUs on the market that will support +12V OCP, and they do not support the multi-rail/single-rail switch operation.

**Q** : Any ideas how far out we are from a launch on this product?

**JS** : We anticipate it to be launched in the fourth quarter of this year. Additional units of varying wattage output levels may also be available at the time of launch.

**Q** : In addition to the new power supply, ENERMAX also showed off a couple new coolers, one of which we are reviewing for this issue. What can you tell us about the newest additions to your LIQMAX line? How do the new LIQMAX II coolers differ from the original units?

**JS** : There are quite a few differences, but there are two that come to mind. First, we've given the waterblock a redesign so that it's more interesting visually, along with the improved internal pump blades that give more lift power, ensuring better coolant circulation inside the closed loop's tubing and radiator. The other big difference is in the fan blade design. It's ENERMAX's new "Batwing" design, which provides 20% more air pressure to force air through the radiator and ensure efficient heat dissipation.

**Q** : Do you also have plans to refresh the LIQTECH line of coolers?

**JS** : Yes, indeed! Our thermal R&D team is working on the second generation of the LIQTECH line. Many new features are still being developed. We shall have more details for you in the coming month.

**Q** : What else should readers be on the lookout for from ENERMAX in the early part of 2015?

**JS** : ENERMAX is constantly in pursuit of the latest technologies in order to incorporate them within our products and manufacturing. There are many products that we are currently working on; however, there isn't much information we can share at this point as those products are still being developed or finalized. What we can share at this time is that a completely new line of cooling devices and PC accessory products is on the way, so please be on the lookout! ■



## Q&A With Aerocool Creative Director Michael Chen

# Get To Know The New Cyclops Advance

**Q:** Can you tell us a little bit about Aerocool's PGS V cases? What characteristics do these cases share, and what kind of usage scenario are they the best fit for?

**MC:** The V stands for "Value" categorized under the Performance Gaming System (PGS). These cases are great for people with a fixed budget who would still like a case that reflects their own personality that they can show off to their peers.

**Q:** What were Aerocool's goals in designing the Cyclops?

**MC:** Cyclops is a fictional character, a superhero and a popular figure among those who love the X-Men. I think the design of the Cyclops case (the front panel) abstractly transmits the idea of Cyclops, and we hope people think it is a cool-looking case to build a gaming PC with.

**Q:** The Cyclops is one of the first cases we've seen that leaves USB 2.0 ports off of the front panel. How did you decide to go with just USB 3.0 ports, and have you received any feedback on that from users?

**MC:** Nowadays, USB 3.0 is gaining popularity, and you can see that in the mix of USB ports on the latest motherboards from major brands, as well as in the availability of more USB 3.0 peripherals. People enjoy the high-speed transmission of data USB 3.0 brings, and because it's



backward-compatible with USB 2.0, we are not worried that leaving USB 2.0 behind is a problem.

**Q:** Builders who like to keep storage drives out of sight will like the SSD mount on the back of the motherboard tray; did you have requests for that prior to designing the Cyclops?

**MC:** The case designers are always trying to fit as many components as possible inside a limited space, and the SSD is becoming a more common choice when it comes to selecting a boot device. As a result—and thanks to the slim design of internal SSDs—hiding an SSD mount behind the motherboard tray made perfect sense. I think we are going to see more of this for smaller form factor cases.

**Q:** Does the Cyclops support the installation of radiators for liquid-cooling?

**MC:** Cyclops can support one 120mm radiator installation for a liquid-cooling system at the rear of case.

**Q:** We notice that you didn't put more drive bays in the middle of the case, and as a result it looks like the Cyclops will hold some pretty large graphics cards. What's the max length the case supports?

**MC:** The max length the case supports is 15.3 inches.

**Q:** The Cyclops' motherboard tray has quite a few slots around the edges for cable management, it looks like. How much space is there between the back of the tray and the right side panel?

**MC:** The slots in the inner rim and the slots in the outer rim are built along different planes. It is suggested that builders route thinner and flatter cables through inner slots, which have roughly 0.7cm of space, and run thicker cables through the outer slots, which provide roughly 1cm space.

**Q:** Which version of the Cyclops has been more popular so far, the Cyclops Advance Black or the Cyclops Advance Red?

**MC:** Black and red are the most popular colors in the market today, and black has always been the "can't go wrong" color for PC-related products. No matter what the color of your other components are, the black case is always in harmony with other colors. ■

# Intel NUC

## Redefining Small, Again

The only thing that rivals computing enthusiasts' love of very large, very powerful PCs is their love of very small, very powerful PCs. Let's face it: a monstrous full-tower machine isn't always the best tool for the job, and thanks to recent advances in CPU power, processor graphics technology, and solid-state storage, you really can have it all now—the computing power you crave and incredible portability in a small, slim form factor.

### Haswell On The Tiny

Intel's NUC (Next Unit of Computing) barebones PC kits have been around for a couple years and change now, and in that time the company has improved these tiny powerhouses in a variety of ways, not the least of which is equipping them with more powerful CPUs. You can even get a NUC with a 4th Generation Intel Core Processor (in either the Core i3 or Core i5 variety), and these kits now offer a new form factor that allows for internal installation of a 2.5-inch SSD or HDD.

### With

If you're after a small form factor PC but still want a self-contained unit with a ton of fast storage, consider Intel's NUC models D54250WYKH and D34010WYKH, which come with an Intel Core i5-4250U processor and an Intel Core i3-4010U, respectively. The Core i5 unit packs Intel HD Graphics 5000, which will drive a 4K display and can simultaneously drive three monitors via its Mini DisplayPort and Mini HDMI ports (requires a Mini HDMI splitter or Mini DisplayPort daisy-chaining), and is as comfortable running games as it is handling your home theater workload.

The Core i3 unit serves up Intel HD Graphics 4400 and is otherwise similarly equipped. Both of these NUCs measure 4.6

inches wide by 4.4 inches deep and are just under 2 inches high, yet there is still room inside for a 2.5-inch SSD or HDD. And because NUC is VESA mount-compatible, you can mount either of these little dynamos on the back of your display, effectively giving them a footprint of zero, or as close as you can get to that.

### Without

If you need something even slimmer, Intel offers NUC models D54250WYK and D34010WYK, which also come loaded with the Intel Core i5-4250U and the Intel Core i3-4010U, respectively, but that don't provide the extra interior space for 2.5-inch drives. Thanks to the omission, these models are a scant 1.36 inches high, but like their slightly thicker siblings, the units are equipped with the same Intel HD Graphics options, the same multi-monitor capabilities, the same built-in Wi-Fi and Bluetooth connectivity, and much more.

In addition, it's important to note that forgoing an internal 2.5-inch drive doesn't mean you have to be without internal storage—these slimmer NUC models also share the larger units' internal full-length Mini PCI-E slots, one for the aforementioned Wi-Fi module and one for an mSATA SSD.



Intel NUC D54250WYKH / D34010WYKH



Intel NUC D54250WYK / D34010WYK

### Small Does It All

NUCs with 4th Generation Intel Core Processors are among the smallest gaming PCs on the planet, but these kits do so much more. Content creation? Check. Home theater. Absolutely. So whether you're looking to shrink your desktop, you need a powerful second machine, or you want a PC in the living room that will perform but stay out of your way, think small. ■



## Aerocool Cyclops Advance Black

Aerocool's PGS-V series cases are designed to provide system builders with quality gaming enclosures at value prices, and the Cyclops Advance Black does just that. It's a smallish mid-tower that's just 16.5 inches high and nearly 16 inches deep (front to back), so it has a fairly small footprint but still easily accommodates full-sized graphics cards and power supplies. The Cyclops Advance's motherboard tray snugly but comfortably accepts ATX boards.

The case's all-black interior is outfitted with all the features you'd expect in a gaming PC case, including cable management slots and a large cutout for installing a CPU cooler, tool-less 5.25-inch drive bays, and a cage that will hold up to three 3.5-inch drives. It even has two dedicated 2.5-inch drive mounts, one of which is on the back (right) side of the motherboard tray, for folks who like keeping drives tucked away out of sight.

The Cyclops Advance comes with two pre-installed fans: an LED-equipped

120mm fan behind its front panel, and a 120mm fan inside the rear panel at the top. If you want to maximize your system's cool-air intake, you can add a second 120mm fan to the front panel, and of course the rear panel's fan mount is also an apt location for a 120mm radiator.

The Cyclops' diminutive size has its advantages. We installed a full system in the case (including a pair of GeForce GTX 970s in SLI, a full-sized power supply, and a closed-loop all-in-one liquid-cooler for our CPU) and found that it was more than capable of accommodating everything you'd need for a serious gaming rig. And although some of the motherboard tray's cable management cutouts aren't accessible with a full-sized ATX motherboard installed, the case's manageable size and weight make it easy to lift and carry, which will be a big plus for frequent LAN party attendees.

We spoke to Aerocool's Michael Chen about the Cyclops Advance (see this

month's "Back Door" interview for more information), and he pointed out that the angular front panel is designed to evoke imagery reminiscent of the case's namesake of "X-Men" fame. This is probably easier to spot in the Cyclops Advance Red than in the Black edition, but the front panel has a cool, aggressive look nonetheless. We also found it interesting that the Cyclops Advance breaks with the past and skips the USB 2.0 ports in favor of a pair of USB 3.0 receptacles.

At just 80 bucks, the Cyclops Advance Black is a solid, affordable enclosure that's roomy enough to easily install everything you need and yet small enough to make all that stuff easy to move around. ■

BY CHRIS TRUMBLE

### Cyclops Advance

\$79.99

Aerocool

[www.aerocool.us](http://www.aerocool.us)

**Specs:** Dimensions: 16.5 x 7.2 x 15.75 inches (HxWxD); Materials: steel, plastic; Motherboard support: microATX, Mini-ITX, ATX; Drive bays: 2 x 5.25-inch external, 3 x 3.5-inch internal, 2 x 2.5-inch internal; Fans (included): 1 x 120mm LED front, 1 x 120mm rear; Fans (optional): 1 x 120mm front; Ports: 2 x USB 3.0, audio I/O



## GeForce Garage DIY SLI

# Planning & Building An NVIDIA SLI Powerhouse

**W**henever we find a resource that seeks to encourage open discussion between seasoned pros, beginners, and everyone in between, we owe it to our readers to bring it to their attention. NVIDIA's GeForce Garage ([www.geforce.com/gfgarage](http://www.geforce.com/gfgarage)) shares our passion for enthusiast computing and offers a host of articles and videos on a variety of topics, including PC building, tweaking, and modding. For more information about SLI and how to make your games look their best, check out GeForce Garage's two-part DIY SLI article, at [bit.ly/1Lh471d](http://bit.ly/1Lh471d) (Part 1) and [bit.ly/1CMYnbG](http://bit.ly/1CMYnbG) (Part 2).

As we reported in our January issue, the NVIDIA GeForce GTX 970 is capable of running current games at 1080p with all the latest eye candy



maxed out, including features such as HBAO+ (Horizon Based Ambient Occlusion), TXAA (Temporal Anti-Aliasing), GPU-accelerated PhysX, and tessellation. With additional support for DirectX 12-based effects baked

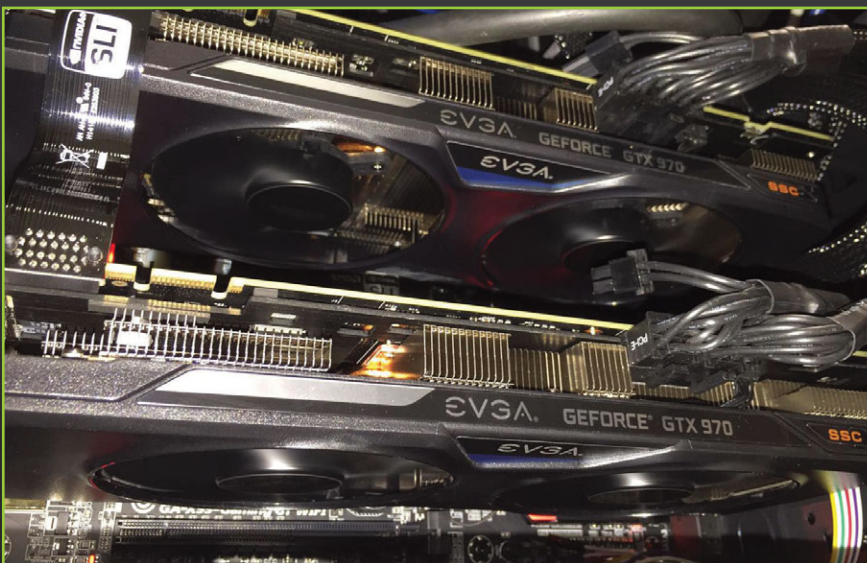
into its DNA, this card is also a highly future-proof option.

However, gamers who run with higher resolutions, such as three-screen displays set to 5,760 x 1,080, and up to 4K, will undoubtedly run into limitations using a single graphics card, even one as powerful as the GTX 970 or 980. Because nobody likes limitations, we'll break down everything you need to build a two-way SLI gaming system that can keep up with the most voracious of pixel appetites.

### Laying The Foundation

Whether you're building from scratch or upgrading your current gaming system, there are a handful of prerequisites that you'll need to be aware of going in. But as long as your existing components—or the ones on your shopping list—are up to scratch, adding the SLI magic is straightforward enough that even novice builders can do it with confidence.

First of all, your motherboard needs to support SLI. Its documentation should specify the exact number of extra GPUs you can run. Your board also needs to have the appropriate expansion slots; SLI-capable graphics cards will take up two expansion slots each, so the x16 PCI-E slots (these are the long, narrow ones) you use will all need to be spaced at least two brackets apart. Most mid-tower PC cases feature seven brackets that correspond to an ATX motherboard's six or seven PCI and PCI-E slots.



Our two EVGA GTX 970s have plenty of room to breathe in this build.

Depending on your platform of choice, the number of PCI-E lanes (the dedicated data links your graphics card has to work with) is dictated by the processor or the chipset. AMD AM3+ chipset-based motherboards, for instance, get their PCI-E lanes from the chipset, so SLI support on AMD-based systems is limited solely by the motherboard. Intel's Z97 and X99 chipset platforms get their PCI-E lanes from the processor. Both the Core i7-5960X Extreme Edition and the Core i7-5930K ship with 40 PCI-E lanes enabled, and either processor in most X99 motherboards will support up to 4-way SLI. The Intel Core i7-5820K supports 28 PCI-E 3.0 lanes, which limits support to up to 3-way SLI. The addition of a PLX chip on the motherboard can enable 3- and 4-way SLI in PCI-E lane-constrained platforms, but this is a third-party ASIC that exists independent of the chipset. In short, if you see a Z97 motherboard that supports 3- or 4-way SLI, chances are good it uses a PLX chip to do it. The GIGABYTE X99 Gaming G1 in our system has enough PCI-E 3.0 lanes to dedicate a full 16 to each of our two GTX 970s.

### Pick The Perfect Power Supply

The other big factor to consider is the power supply. To do it right, you'll have to determine how much



With a PSU like this, SLI is no problem at all.

juice is required to handle your components. Start by adding up the TDP (thermal design power) limits of your CPU and graphics cards; overclockers should double each number to account for the dramatic rise in TDP that may occur when raising voltages, and then add 100 watts to cover your fans, hard drives, SSDs, memory, motherboard, and other parts. Our pair of EVGA GeForce GTX 970 SSC ACX 2.0+ cards consume 145 watts each, doubled again for overclocking, added to the 140 watts that our Intel Core i7-5960X Extreme Edition consumes (doubled to 280 watts), plus the extra 100 watts for extra components puts us over 960 watts. Yeah, it adds up fast.

EVGA's 80 PLUS Platinum-certified SuperNOVA 1,000-watt PSU (Model 220-PS-1000-V1) is a solid choice for our build. It is SLI Ready, fully modular, has up to 10 6+2-pin

PCI-E power connectors (we only need four to power our pair of GTX 970s), and comes with an impressive 5-year warranty.

The rest of SLI's minimum system requirements include Windows 7 (32- or 64-bit) or newer and at least 2GB of RAM (4GB for 64-bit OSes). To ensure that no aspect of a game that relies on the CPU hampers our performance, however, we'd recommend 8GB of RAM at minimum.

### The SLI Secret Sauce

Now that we have our foundation (we're also using a 240GB OCS SSD, 16GB of Crucial DDR4-2400 memory, and Windows 8 Enterprise), we can install our GPUs and start enjoying the performance increases.

The key to installing a pair (or more) of graphics cards is to look at the motherboard manual to determine which PCI-E slots you should use. GIGABYTE recommends we start with the slots labeled "PCIE\_1"

## NVIDIA GeForce Garage

Are you a gamer looking to get into PC building? Visit NVIDIA's GeForce Garage ([www.geforce.com/gfgarage](http://www.geforce.com/gfgarage)) to get building advice, modding how-to videos, and numerous tutorials written in plain English. Even if you're just a beginner, you can work your way through to a performance-tuning PC-modding master with NVIDIA's help.



and "PCI-E\_2," which are the first and fifth PCI-E slots below the CPU socket.

Starting with the system powered off and unplugged (and all other components installed), we plugged the graphics cards into the respective slots, plugged the corresponding PCI-E power cables from the PSU into each card's 6- and 8-pin power connectors, and installed the 2-way SLI bridge connector that shipped with the motherboard. (You can use either of the two SLI leads, as position doesn't matter.) Next, we rebooted the system, launched a browser and navigated to [www.nvidia.com](http://www.nvidia.com), and downloaded the latest drivers.

After installing the driver and rebooting for good measure, you can right-click an empty space on the Desktop and click NVIDIA Control Panel. Click

## Bonus Offer: Get Your Hands On SLI, Get A Free Copy Of Dying Light

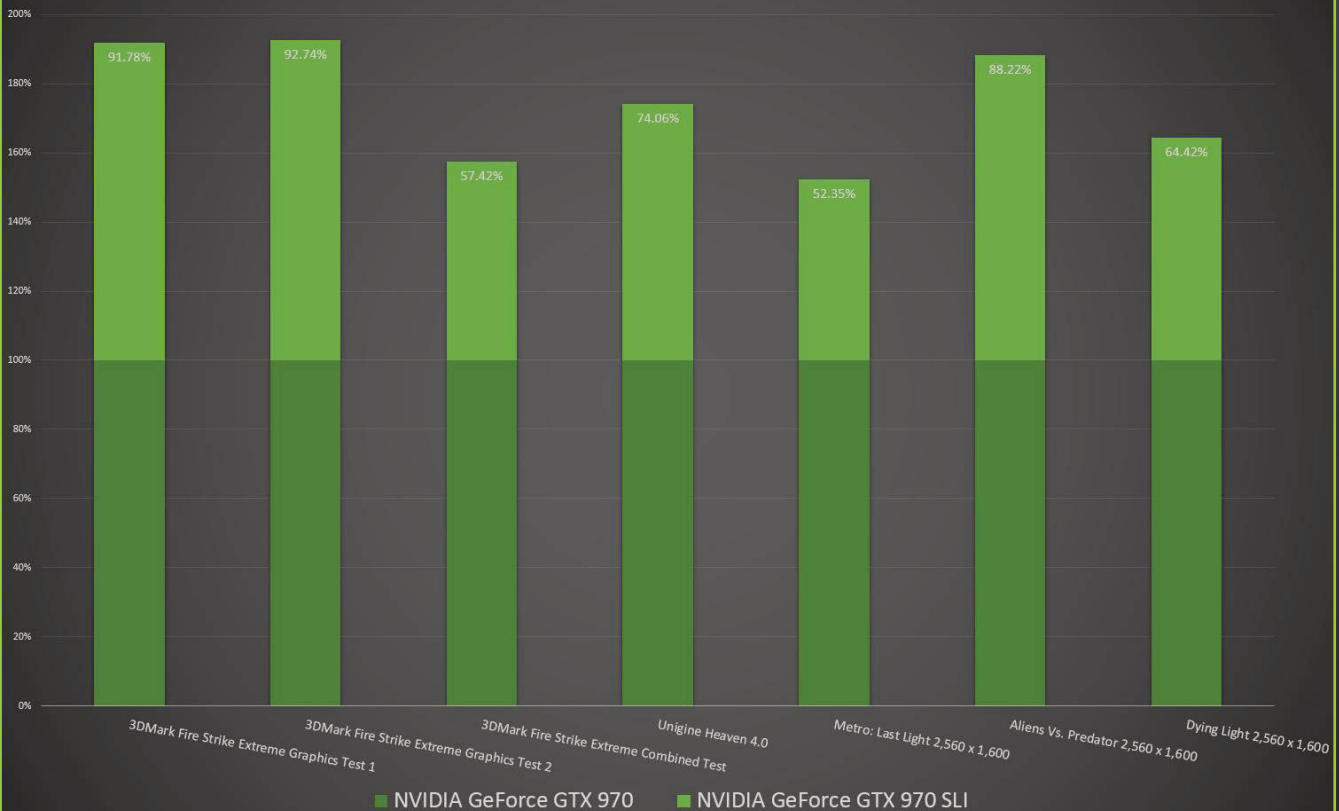
We've shown you how easy it is to set up SLI, now we're making it even easier to get your own slice of SLI heaven. NVIDIA and CPU magazine have partnered to offer our readers a free copy of the co-op zombie-slaying hit Dying Light when making a qualifying purchase. Visit [www.evga.com/cpumag](http://www.evga.com/cpumag) for more details.

Configure SLI, Surround, and PhysX to open the menu, then click Maximize 3D Performance and click the Apply button in the bottom-right corner of the NVIDIA Control Panel. The screen will flash as SLI comes online, but when it's finished, a green bar indicating SLI will span the two boxes that represent your graphics cards.

## Knockout Performance

As you can see, SLI scaling spans between 52% and 92% at the highest resolutions, which is enough to ensure this system handily outperforms any single-GPU system by a good margin when running these games. Best of all, SLI is easy to set up and the benefits are immediately evident. Now *this* is the way games are meant to be played. ■

NVIDIA GeForce GTX 970 SLI Performance



SLI scaling on the suite of games we tested was good, and as driver performance improves, scaling often gets even better.



# State-Of-The-Art Standards

## 5G

Some of the technologies we talk about in “State-Of-The-Art Standards” are slow burners, like PCI-Express or SATA; they’ve been evolving for a decade or more and in most cases we can clearly see where they’re headed, or not headed anytime soon, as is sometimes the case. Others, like 5G, are more nebulous. As we went to press, few crucial facts exist about the technology’s proposed operating frequency, theoretical and real-world bandwidth, and the far-flung launch date after which we’re likely to begin seeing mobile operators tout its advantages. Despite the lack of tangible details available, there’s still plenty to discuss about the next standard for mobile networking.

### Background Noise

Mobile networking technologies have more in common with terrestrial telecommunications than they do with other wireless technologies, such as Wi-Fi and Bluetooth. Moving to 802.11ac, for instance, is a fairly straightforward process that starts with the standardization body defining the specification and chipset manufacturers building ICs, followed by consumer electronics that use the new spec rolling out on store shelves.

The respective rollouts of 2G, 3G, and 4G LTE (Long-Term Evolution) all depended on carriers establishing an infrastructure, base stations, cell towers, etc., and a close collaboration with phone manufacturers to deliver devices that can benefit from the service providers’ new network.

Another way in which cellular networking standards differ from Wi-Fi standards is in compatibility. For the most part, there is no backward compatibility



There's a new wave coming.

between cellular generations. In order for a phone to communicate with 2G, 3G, or 4G base station equipment, it must

switch between radios that communicate using the respective generation’s distinct switching technology.



The earliest mobile phones just barely met the classification.

The carriers and service providers responsible for installing the infrastructure and selling subscriptions have a delicate balancing act to perform. On one hand, they need to continually upgrade to keep up with customer demand, but they need to do it in a way that doesn't render their significant infrastructure investments obsolete every few years. This balancing act has led to some fuzzy distinctions between mobile networking generations, as we'll describe later. Understanding these factors are an important part of making sense of why 5G is going to take its sweet time in getting here.

### The Mobile Network Family Tree

The earliest form of automatic cellular phone service, NMT (Nordic Mobile Telephony), launched in 1981. The budding cellular network's customers were centralized in Sweden, Norway, Denmark, Finland, Saudi Arabia, and eventually Iceland. The

first phones it used were compact enough to fit in the trunk of a car, with the keyboard and display mounted to the dashboard. Aside from the bulky phones, the big weakness here was the fact that a simple radio frequency scanner could let eavesdroppers listen in on conversations.

Approximately a decade later, Finland introduced the world to 2G, or the second-generation mobile network, which primarily utilized one of two multiplexing methods to operate. The resulting pair of technologies were effectively competing standards. GSM (Global System For Mobile Communications) uses TDMA (Time Division Multiple Access) to divide the signal into different time slots, thereby enabling multiple users to share the same frequency channel. iDEN (Integrated Digital Enhanced Network) is another TDMA-based cellular network technology that was used

largely in North America, with subscription services available from Sprint Nextel, though the carrier decommissioned its iDEN network in 2013. The other primary multiplexing method, CDMA (Code Division Multiple Access), employs spread-spectrum technology and a special coding scheme to let multiple transmitters communicate simultaneously on a band of frequencies. GSM gained the most traction in Europe while CDMA-based services were more common in North America. Today, GSM has become the dominant 2G cellular networking technology used worldwide.

At this point in the evolution of cellular networks, voice was still the focus of a majority

of the transmissions, but data services and proto-smartphones were already introducing unique challenges for operators. Before 3G's formal launch, operators had begun to add a packet-switched domain to its existing circuit-switched domain, courtesy of GPRS (General Packet Radio Service), which was built on the foundation of preceding packet-switched cellular technologies CDPD (Cellular Digital Packet Data) and i-mode (popular in Japan). GPRS was originally defined by the ETSI (European Telecommunications Standards Institute). When it debuted, the packet-based mobile data standard was often referred to as a 2.5G specification and although it wasn't faster than the circuit-switched data services, it enabled carriers to charge subscribers based on data download and upload volumes separately from talk time-based billing for voice services.

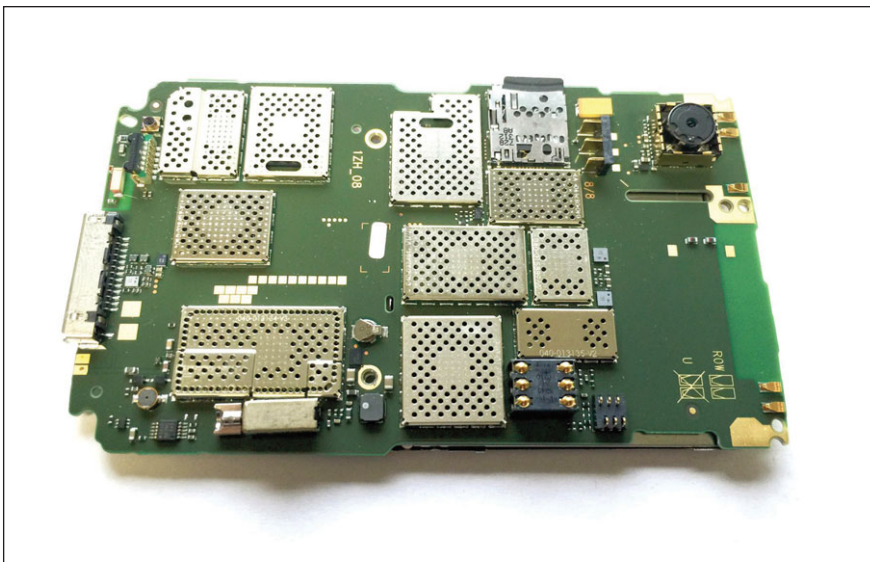


The Motorola DynaTAC 8000X was one of the most popular mobile phones of the '80s and '90s.

In 1998, the primary standards development organizations that were working on mobile broadband technologies, including the ETSI, banded together to form the 3rd Generation Partnership Program, or 3GPP. This organization was tasked with producing all the technical specifications and reports for a 3G mobile networking system based on current core mobile networking protocols.

The transition between 2G and 3G networks is murky, but most agree that CDMA2000 was one of the foremost enabling technologies. As the name suggests, it uses Code Division Multiple Access signaling to transmit voice and data between cell sites and cellphones. CDMA2000, sometimes called C2K or IMT Multi-Carrier, changed over the course of its lifetime. CDMA2000 1xRTT (Radio Transmission Technology, standardized as IS-2000) was the initial revision and it supports data rates up to 153Kbps in both directions and up to 35 simultaneous calls per sector (sometimes more), which is double the calls that IS-95 networks, the 2G specification, could handle. The International Telecommunications Union recognized the standard in November 1999.

The standard got its initial overhaul in the form of the CDMA2000 1X



Interference can become problematic for cellphones that support multiple cellular radios.

EVDO (Evolution Data Optimized) revision, which focuses on improving data transmission speeds. The first commercial CDMA2000 1xEVDO network launched in Korea in 2002. EVDO Release 0 users saw peak data download rates of 2.4Mbps and peak data upload rates of

153Kbps. CDMA2000 1xRTT handled data at a rate of just two to three times that of a dial-up modem. EVDO Rev. A, however, raised the bar again with download rates approaching 3.1Mbps and upload rates up to 1.8Mbps. Other improvements included latency decreasing to 50ms (milliseconds), VoIP-centric support for multi-user packets that can carry data from as many as eight users simultaneously, and QoS (Quality of Service) flags for better prioritization.

The 3GPP had plans to add a voice component to the EVDO specification called CDMA2000 1X EV-DV (Evolution Data and Voice), but as EVDO equipment rolled out, carriers were able to transmit voice as VoIP calls on Data Optimized packet-switching technology, or simply downgrade to the still adequate CDMA2000 1X RTT specification. According to the CDMA Development Group, as of May 2012 there were 329 operators in 121 countries offering either or both CDMA2000 1X and EVDO services. In North America, most carriers that rolled out EVDO-based networks are still operating them, with several planning to discontinue support for the aging networking standard between 2015 and 2017.

For GSM network operators, the path to 3G included a stepping stone called Enhanced



The addition of packet-based switching was crucial to the evolution of mobile networks.





An outdoor signal booster kit like this one can improve cellular reception in a limited area.

Data rates for GSM Evolution, or EDGE (as part of the 3GPP's IMT-2000 family of 3G standards). This technology takes advantage of 8-PSK (Phase-Shift Keying) to deliver backward compatibility; support for caller ID, call forwarding, and short messaging; and significantly higher data transmission rates compared to GPRS. EDGE, technically considered a 2.75G mobile broadband protocol, supports bandwidth up to 236Kbps and end-to-end latency of less than 150ms for four timeslots (up to a theoretical maximum of 473.6Kbps for eight timeslots) in packet mode. This equates to a four-fold increase compared to 2G GPRS. AT&T was instrumental in deploying EDGE in North America, starting in 2003.

A loose definition of 3G describes any network capable of sustaining data rates up to or above 200Kbps. Although EDGE met that requirement, it was never really up to the task. GSM's real taste of 3G came in the form of another 3GPP standard, UMTS (Universal Mobile Telecommunications System), sometimes referred to as 3GSM. It was created specifically to compete with EVDO. UMTS achieves greater spectral efficiency and higher bandwidth by leveraging Wideband Code Division Multiple Access (W-CDMA) radio

technology, but as a result, required new base stations and fresh frequency allocations. A complete UMTS network consists of a UTRAN (UMTS Terrestrial Radio Access Network), the core network MAP (Mobile

Application Part), and the authentication of users via SIM (Subscriber Identity Module) cards.

Work on what would eventually become known as 4G began as early as 2001. A Qualcomm-funded CDMA2000-based 4G option under development called UMB (Ultra Mobile Broadband) was abandoned in 2008 in favor of a competing technology called LTE (Long-Term Evolution), which went on to full rollout in Scandinavia a year later.

### The 4G World As We Know It

For most users in North America today, 4G LTE offers a tangible performance increase compared to 3G and coverage areas are growing at a good pace. According to Germany-based GfK, smartphone sales last year totaled more than 1.2 billion units. GSMA Intelligence reports that by the end of January 2015, there were 352 operators worldwide running commercial 4G-LTE networks in more than half of the world's mobile markets. Gartner recently predicted that 4G LTE data use would grow by 59% in 2015 alone and that data usage per smartphone would reach 5.5GB per month by 2018.



You won't be able to tell the difference between a CDMA and GSM phone just by looking at it.

4G LTE, or the 3GPP Release 8 specification, consists of UMTS system extensions and modifications, called EUTRAN (Evolved UMTS Radio Access Network). LTE also has garnered the support of CDMA and GSM service providers alike. Although it didn't have the bandwidth to be considered true 4G initially, the ITU ultimately relaxed its requirements to allow LTE to achieve the 4G designation. As such, LTE uses packet switching to transmit both data and voice, making much more efficient use of the frequencies previously dedicated to 3G communications.

LTE's core technologies, OFDM (Orthogonal Frequency Division Multiplexing) and MIMO (Multiple Input/Multiple Output), have already proven their aptitude in handling high-bandwidth applications in 802.11n networking and WiMAX. OFDM and MIMO work together to split a single data stream into multiple streams for transmission to and from multiple antennas. The resulting high-data-rate, low-latency stream will transmit at rates between 100Mbps and 160Mbps, making it ideal for both fixed and mobile networking uses. The vastly-improved bandwidth also enables LTE service providers to support applications such as streaming HD video, streaming music, more simultaneous calls in a given area, video conferencing, gaming, and more. When transmitting voice (via VoIP), an LTE connection is capable of bringing VoIP latencies to as low as 20ms, vastly improving the experience and paving the way for mobile video conferencing. 4G LTE's big rollout occurred in 2011.

## 4G & Beyond

As mobile networking technologies go, we're still in 4G LTE's adolescence, but the 3GPP and other industry organizations are already working on a successor technology called LTE-Advanced. The goal of the new revision is to support peak data rates that rival fiber-based networks, 100Mbps when a user is in motion and up to 1Gbps for stationary downloads. This is much closer to true 4G. Although it won't be a dramatic improvement over existing 4G LTE, the new revision will mean the connected sessions are more consistent and reliable across the



5G is likely to blow today's best mobile networking technology away.

network. To get these upgrades, however, carriers will need to deploy upgrades to the radio access network and users will need new handsets. In March 2014, AT&T unveiled an LTE-Advanced network in Chicago and other markets and used carrier aggregation techniques to bond together two separate radio channels (700MHz and 1.7GHz) to achieve 110 Mbps data rates.

Researchers at Core Forecasting report that all four major carriers in North America have either commercially deployed or are in the process of actively deploying LTE-Advanced networks, and at the end of 2014, 7.8% of the population had access to LTE Advanced.

## Getting A Whiff Of 5G

Having traced the decade-by-decade development of mobile broadband, we can make a few assumptions about 5G's likely path to reality. First of all, in order to significantly improve mobile bandwidth over 4G LTE Advanced, carriers will need to invest heavily in new radio access network hardware at cell sites and mobile users will need smartphones with the appropriate capabilities.

The Germany-based organization dedicated to defining the standard, the NGMN (Next Generation Mobile Networks) Alliance, has stated that for a technology to be considered 5G, it must support several tens of Mbps data rates for tens of thousands of simultaneous users, 1Gbps data rates for tens of workers simultaneously on the same office floor, up to several hundred-thousands of simultaneous connections for large coverage areas, improved spectral efficiency compared to 4G, large coverage areas, and deployments occurring by 2020.

If some of those stipulations seem vague, that's the point. Rolling out new mobile broadband technologies is about finding middle ground between what's theoretically possible and what the collective of carriers is willing to bankroll.

This biggest limitation 5G technology developers will run into is trying to improve peak bitrate using the same frequency bands. Each new mobile generation to date has had the benefit of wider spectral bandwidth per frequency channel. For instance, 2G services have access to 1G's 30kHz up to 200kHz, 3G was granted access to up to 20MHz, and 4G systems could tap into the 100MHz band. Retiring old services could help a little, but some experts suggest that there aren't any viable mobile broadband radio frequencies left to expand into. The band of frequencies between 600MHz and 3GHz are ideal for wireless communications. Waves become too large below 600MHz, necessitating larger antennas, and above 3GHz, range becomes a problem, requiring more cell sites, which would dramatically increase the costs of rolling out a new network.

Techniques such as spectrum sharing (using licensed spectrum in a way that doesn't cause interference), carrier aggregation (two frequency bands acting as one), advanced beam-forming (a form of signal processing that makes omnidirectional arrays perform better in one, two, or three directions), and dense MIMO (multiple-input and multiple-output) antenna arrays are all being investigated as potential solutions to the existing limitations.

Aside from higher peak bandwidth, 5G may come to represent technologies that enable a higher number of simultaneously connected devices, improved data volume per area unit, more energy-efficient radios, improved reliability over a larger coverage area, better latencies, and more.

Whatever form 5G takes in the coming years, getting there will come at a cost to both consumers and carriers alike. But as much as we rely on smartphones today, it's hard to envision either group being reluctant to pony up for faster and more reliable Internet access, higher-quality media streaming, and better coverage from our mobile devices. ■



# March Madness

March stinks. In most of the United States, the temperature still ranges anywhere from chilly to frigid. Want to avoid the harsh elements with some indoor entertainment? That's tough, when most blockbuster movies and AAA videogames typically avoid March release dates. If you're a student, you have a week of Spring Break to dull the pain. If you've graduated to adulthood, the only thing you have to look forward to is scraping together your financial records in the vain hope you'll actually do your taxes ahead of schedule this year.

We at *CPU* can no longer abide this dull and dreary month. As we open up the *CPU* System Workshop for the second time this year, we set out to inject the month of March with a little excitement, and we're doing it the only way we know how: by building a slammin' custom system.

In 2015, it helps that PAX East rolls into Boston on March 6 for three days of gaming revelry. And of course, every year college basketball fans live for the NCAA Tournament. This being our sixteenth build, we decided to recognize roundball enthusiasts by dubbing the system "Sweet Sixteen." Once you check out the all-star lineup we managed to assemble for this system, we think you'll agree that "sweet" doesn't begin to cover it.

Get your drinks, nacho trays, and giant foam fingers ready. This one's going to be a barn burner.

## Full-Component Press

Our lineup starts with a CPU that's a proven winner, Intel's Core i7-4790K.

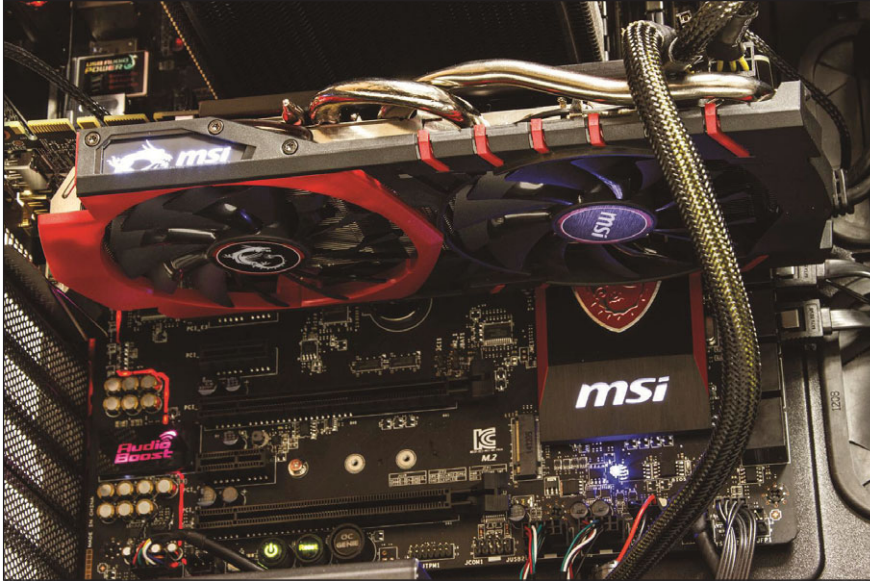
Formerly code-named "Devil's Canyon" (which, as an aside, has to be the coolest code name we've run across since Operation Overlord), the 4790K takes all of the goodness of the Haswell microarchitecture and makes it better. It's a four-core speed freak, with a base clock of 4GHz and a maximum Turbo frequency of 4.4GHz. Additionally, Intel has applied its NGPTIM (Next-Generation Polymer Thermal Interface Material) between the processor's die and integrated heat spreader, so we reckon there's room for more turbo

when you're ready to play with the 4970K's unlocked multiplier.

MSI's Z97 GAMING 7 serves as our base of operations. It's clear that this board is built for gamers, with support for 2-way SLI/CrossFire and 3-way CrossFire, a PS/2 and two USB ports optimized for gaming, a Killer E2200 network controller, and a copy of XSplit Gamecaster. However, MSI didn't just min-max the Z97 GAMING 7 exclusively for gaming, since it's also brimming with features that any power user covets, such as four DIMM slots







that can support up to 32GB of DDR3-3300, an M.2 slot that can work over the PCI-E bus for potential throughput that can exceed 6Gbps SATA speeds, MSI's Military Class 4 components, Click BIOS 4, and more. Primarily black with splashes of red and adorned with MSI's GAMING Dragon logo, the Z97 GAMING 7 is dressed to impress, too.

We liked the Z97 GAMING 7 enough to double down and recruit more MSI hardware for Sweet Sixteen, specifically its graphics. Factory overclocked out of the box, the GTX 970 GAMING 4G LE gives NVIDIA's GeForce GTX 970 GPU the proper treatment. In addition to two overclocked modes, the GTX 970 GAMING 4G LE features MSI's brand-new Twin Frozr V cooler. With the Twin Frozr V, MSI has upped its game yet again. The cooler's two 100mm Torx fans are revamped, increasing air dissipation without an accompanying increase in fan noise. The brainiacs in MSI's engineering department figured

out how to drive down fan noise even further by designing them to operate independently from one another as thermal loads dictate. Add a Silent Mode to the mix, and the GTX 970 GAMING

4G LE is never louder than it needs to be. It prefers to make noise in-game rather than in your case.

Sweet Sixteen is outfitted with a kit of PNY XLR8 DDR3. We snagged a pair of 8GB sticks, which means our system is one more 16GB kit away from maximizing the Z97 GAMING 7's memory support. The 1,866MHz clock speed and CAS 9 latency are solid, and the modules are draped with ultra-sleek heat spreaders.

The solid-state drive we loaded into the system is new, fast, and roomy—a 500GB Crucial MX200. We can't even call this bad boy a boot drive, because there's enough capacity to install games and apps in bunches, in addition to the operating system. As far as performance goes, the MX200 smolders, with advertised sequential reads and writes of 555MBps and 500MBps, respectively, and random IOPS of 100,000 read and 87,000 write (at a queue depth of 32). The controller and firmware tag team at the heart of the







MX200 can pull off a fair bit of magic, too, with technologies that minimize energy use (Extreme Energy Efficiency and Adaptive Thermal Protection) and maximize data safety (RAIN, four layers of Exclusive Data Defense, 256-bit AES encryption).

To power Sweet Sixteen and keep its 4790K cool, we turned to a pair of European companies for their wares. Our system's power supply comes to us from Fractal Design, the Swedish manufacturer renowned for its minimalistic yet stunning cases. We've always been keen on Fractal's cases, so the company's NEWTON R3 PSU seemed like a good choice. As an 80 PLUS Platinum-certified power supply, the NEWTON is one of the most efficient powers supplies money can buy. The unit's single 12V pumps out 66A of current, and the semi-modular design leaves the essential cables hardwired while giving enthusiasts total control over the rest. Throw in premium Japanese capacitors and a fan that only spins if it needs to, and you have a PSU that's as smart as Sir Isaac himself.

The system's CPU cooler is a rock in both name and performance. The Dark Rock Pro 3 from the German company be quiet! is an air cooler on a mission to destroy heat. Truly monumental, the Dark Rock Pro 3 has seven 6mm copper heatpipes, two towers of densely packed aluminum fins, and a pair of be quiet! SilentWings fans (one 120mm, one 135mm). All of this is piled atop a copper base, plated in dark nickel, and then capped with a brushed aluminum cover. Incredibly, the Dark Rock Pro 3 has a cooling capacity of 250W TDP while keeping its noise below 26.1dBA; rarely do we see a cooler so powerful yet so quiet at the same time. Our Core i7-4790K was in good hands with this cooler.

For a component that's a heck of a lot of fun to look at, Aerocool's Touch 2100 fan controller is also quite practical. Sure, you'll come for the incredible 5-inch touch-sensitive

LCD screen, but you'll stay for the five fan channels and temperature probes. We've tried a lot of fan controllers over the years, and the Touch 2100 is among our favorites. The unit supports up to 25W per fan channel, which can ultimately power and control quite a few fans. The temperature probes are a great way to keep tabs on your various components' thermals. The Touch 2100 requires a pair of 5.25-inch bays, but that stunning LCD (with seven available backlight colors) more than justifies the space.

We loaded all of our components into a beastly case that's also quite a beauty. At 22 inches tall, ENERMAX's new Thormax GT is the definition of towering, but it has plenty of style, too. It ships with a pair of 180mm blue LED fans (and one regular 120mm rear exhaust fan), which is a good opportunity to mention that ENERMAX sent us a collection of red LED T.B. APOLLISH and T.B. VEGAS fans to match Sweet Sixteen's red and black hardware. (So no, your eyes don't deceive you.) The Thormax GT supports motherboards up to E-ATX, graphics cards up to 14 inches long

(and the graphics card clearance jumps up to 19 inches with the top drive cage removed), and 360mm radiators. It had plenty of room to grow even after we installed all of our components.

With 15 builds already under our belts, we admit it can be difficult to maintain the element of surprise, but we're finishing our roster with a good one. A lot of times, you can identify the die-hard LAN partygoers not by their systems but by their chairs. The veterans know that a weekend of gaming requires more than a steady supply of energy drinks and pizza, so they'll bring along a chair to recline in comfort. With that in mind, we give you one of DXRacer's PC gaming chairs, specifically model OH/FE08/NR. Part of DXRacer's Formula Series, this chair is an upgrade for the most important part of any gaming setup: the gamer. Knowing that power users care about the specs of anything, DXRacer made sure its Formula Series chairs are top-notch. The chair has passed 72 quality tests and uses a hydraulic unit from Germany. We dare you to park your posterior into one of these thrones and go back to the cold, unforgiving folding chairs provided to the LAN party peasantry.

## Hammer Dunk

As usual, we have a system full of top-tier parts. Stocked with a fast processor, killer graphics card, ample system memory, and a smokin' SSD, Sweet Sixteen is primed to dominate the competition. We have a full component-by-component rundown on the following pages, followed by a postgame report on Sweet Sixteen's benchmark performance.

After that, we're putting the system on our team bus (or freight truck, whichever's cheaper) with a ticket to Boston. At PAX East, it will show off its game before we ink it to a long-term contract with one lucky future owner. ■




**DXRACER**

# Formula Series OH/FE08/NR

We all know that binge gaming can be hard on the back, neck, and arms, especially if you have poor posture. We imagine the lucky winner of our Sweet Sixteen will spend a lot of time using the system, so we wanted to provide him or her with a comfortable, ergonomic chair to avoid any muscle soreness or cramps. We chose the Formula Series OH/FE08/NR from DXRacer, a company that began as a manufacturer of car racing seats and has ported its research and design over to computer chairs. Today, DXRacer uses its 10 years of ergonomics research to provide the optimum structure curve and ideally support your spine.

The Formula Series OH/FE08/NR is completely customizable. The back of the chair can adjust up to 170 degrees, so you'll be able to game in the position you find most comfortable. No need to keep your seatbacks in the upright and locked position here. The Formula Series makes use of handy hydraulics to quickly raise and lower your chair.

There are also footrests built into the star-shaped base, which you can use to keep your ankles up and feet off of the ground. The footrests also provide an alternative to the ground as a location for your feet, which in turn gives you the ability to bend your knees when you want to vary your position. DXRacer indicates that variance is key to ergonomic sitting.

For ultimate comfort, DXRacer also provides a headrest cushion and lumbar cushion, which you can easily add or remove to suit your preferences. The arm



rests are adjustable, too. DXRacer prides itself on using high-quality materials. The chair is covered in PU leather that's soft to the touch and replicates the feel of a genuine racing seat. In short, superb comfort awaits the lucky winner of the Sweet Sixteen.

The Formula Series is ready for the rigors of travel, too. DXRacer uses an all-steel framework to ensure durability, and the chair's steel frame is supported by a lifetime warranty. Chair parts (not including the natural wear of the PVC or PU leather) are backed by a two-year

warranty. All of the accessories must pass 72 strict quality tests. This chair supports up to 265 pounds.

The OH/FE08/NR even matches the Sweet 16's red and black color scheme. We recommend you come by our booth at PAX East and give it a sit. Comfort and ergonomics, after all, are something that you'll want to test out yourself. ■

## Formula Series OH/FE08/NR

\$349

DXRacer

[www.dxracer.com](http://www.dxracer.com)

## SPECS

Color: black and red; Cover: PU; Armrests: Adjustable; Base: Aluminum; Weight limit: 265 pounds; Accessories: Headrest cushion and lumbar cushion




**CRUCIAL**

# MX200 500GB

Whether you need to give your aging system a much-needed kick in the shorts or you want to start a new system off on the right foot, one of the best ways to accomplish either mission is with a standout solid-state drive. True, we've reached a point where SSDs are now just another component to include in a build, rather than an exotic upgrade, but that simply means that there are now dozens of worthy options available. In that regard, picking the right SSD might be more challenging than ever.

Thankfully, Crucial makes that choice a little easier, at least as far as this build is concerned. The company released its line of high-end MX200 solid-state drives just in time for this session of *CPU System Workshop* (awfully sporting of them). We settled on the 500GB MX200 in a 2.5-inch form factor, although this is just one of the many choices available in the expansive MX200 family. You can go bigger (1TB) or smaller (250GB), and opt for three additional form factors—mSATA, M.2 Type 2260, and M.2 Type 2280—as well. (The mSATA and M.2 MX200s were not available in 1TB capacities at the time of this writing.) Regardless of form factor, the MX200 SSDs all have the same advertised speeds, so now the storage subsystem for your laptop, nettop, mini PC, or HTPC can be just as fast as your desktop.

And make no mistake, this drive is fast. Sequential reads and writes both exceed 500MBps, and random reads and writes are similarly superb. When you saturate these drives with 32 data requests, their throughput crests to 100,000 IOPS (reads) and 87,000 IOPS (writes.) It handles single random requests capably, as well.



For a company that has been developing SSDs for as long as Crucial has, it comes as no surprise that the MX200 offers a lot more than raw performance. In addition to helpful technologies like RAIN, Exclusive Data Defense, and Adaptive Thermal Protection, the MX200 SSDs have the Crucial Storage Executive at their disposal. This toolbox lets you easily update your drive's firmware, check its operating temperature and overall health, reset its encryption password, and more. Expect

Crucial to fill this toolbox with even more tools over time.

Sure enough, the 500GB MX200 soared through our storage benchmarks. We imagine it will reach similar heights in a system of your own creation, and at less than \$0.45 per GB, this drive won't break the bank, either. ■

## MX200 500GB

\$219.99

Crucial

[www.crucial.com](http://www.crucial.com)

## SPECS

Interface: 6Gbps SATA; Controller: Marvell 88SS9189; Maximum sequential read/write: 555MBps/500MBps; Random read: 100,000 IOPS (QD 32); Random write: 87,000 IOPS (QD 32); Form factor: 2.5-inch; Warranty: 3 years



MSI

# GTX 970 GAMING 4G LE

When it comes to gaming, even the noobiest of noobs knows that a cutting-edge GPU can be the deciding factor between victory and defeat. NVIDIA's Maxwell GPU architecture undeniably fits that description, so outfitting Sweet Sixteen with a Maxwell-based graphics card seemed like a no-brainer. Up to bat is MSI's GTX 970 GAMING 4G LE.

The GeForce GTX 970 GPU at the heart of this card is an impressive piece of silicon. To do the heavy 3D lifting, the GTX 970 has 1,664 CUDA cores, 104 texture units, and 56 ROPs at its disposal. At stock speeds, the GPU core cruises at 1,051MHz and jumps up to 1,178MHz in Boost mode. The 4GB of VRAM are clocked at 1,750MHz.

MSI's take on the GTX 970 clearly improves on the reference design. The GTX 970 GAMING 4G LE's core runs at 1,051MHz, but before you think that's the wimpiest factory overclock of all time, you have to realize that's the card's speed in Silent Mode. MSI also included two proper overclocked modes: Gaming Mode (1,064MHz) and OC Mode (1,076MHz). The Boost clock increases, too, to 1,203MHz and 1,216MHz, respectively.

A big part of the reason the GTX 970 GAMING 4G LE is overclocked out of the box is MSI's brand-new Twin Frozr V cooler. A product of 18 months of R&D, the Twin Frozr V is brimming with improvements. A series of four heatpipes (two 8mm, two 6mm) wind their way through the heatsink fins. Combined with a massive, nickel-plated copper base, the heatpipes and fins are able to effectively siphon away heat from the GPU. After that, a tandem of 100mm fans



GTX 970 GAMING 4G LE

\$339

MSI

us.msi.com

takes over; here, MSI's engineering acumen is on full display. The Torx fans' Advanced Dispersion Blade design produces extra airflow while managing to avoid any increased drag, which keeps the fans quiet. The fans don't spin at all if they're not needed, and when they do, MSI has configured them to operate independently. If one of the fans isn't needed as much, it doesn't have to spin at the same speed as its partner in crime, further keeping noise to a minimum.

The GTX 970 GAMING 4G LE is more than clocks and cooling, though. It's built

with MSI Military Class 4 components (Hi-c CAPs, Super Ferrite Chokes, Solid CAPs), which help extend the life of the card and keep it stable under punishing workloads. And when you're punishing the competition, MSI's Predator software can capture the video and save a copy for you to relive your victories.

Perhaps the best part about the GTX 970 GAMING 4G LE is its price. Right around \$340, this graphics card gives you flagship-level performance at a cost that won't sink your budget. ■

## SPECS

GPU: 28nm Maxwell; Clocks: 1,051MHz/1,064MHz/1,076MHz (core), 1,178MHz/1,203MHz/1,216MHz (boost), 1,750MHz (memory); Memory bus: 256-bit; Frame buffer: 4GB; Factory overclocked: Yes; Ports: Dual-link DVI-I, Dual-link DVI-D, HDMI, DisplayPort





**BE QUIET!**

# Dark Rock Pro 3

The great CPU coolers are those that stop the mercury in its tracks. The best coolers are the ones that stop LAN party passersby in their tracks, too, demanding that they get a closer look. It's a standard that most units aspire to but usually fall short of in one way or another. Then there are the coolers that nail it. They stick with us, long after we've reviewed them. The Dark Rock Pro 3 from be quiet! made a lasting impression when we put it to the test last year (check out the April 2014 issue), so we had no reservations tapping it to cool our system's Core i7-4790K.

Measuring 6.4 x 5.2 x 4.8 inches (HxWxD), the Dark Rock Pro 3 is unapologetically large, which means a couple of things. First and foremost, its cooling capacity is borderline outlandish: According to be quiet!, the Dark Rock Pro 3 can dissipate up to 250 watts of heat, which easily covers any desktop processor you want to throw at it. Ambitious overclockers will have the means to punch in impressively high frequencies. Second, the cooler's dimensions afford about 1.5 inches of clearance for your system memory, provided you motherboard's DIMM slots wind up in the Dark Rock Pro 3's shadow. With a cooler like this, you'll want to find a way to make it happen.

A closer look at the heatsink's construction reveals how the Dark Rock Pro 3 can get away with such a gaudy thermal ceiling. A copper base and copper heatpipes (seven, 6mm thick) are present and accounted for, naturally, as are two towers of aluminum fins. Thanks to the fins' dynamic wave-contour cooling technology and an array of tiny dimples on



the surface of the fins themselves, the Dark Rock Pro 3's heatsink is able to improve air flow and increase cooling surface area without contributing more noise.

And as far as noise goes, would it surprise you to learn that a company named "be quiet!" manufactures its coolers to quietly go about their business? The cooler's pair (one 135mm/1400rpm, one 120mm/1700rpm) of SilentWings fans produce a blustery 113.8cfm (135mm) and 93.3cfm (120mm) of airflow while staying below 26.1dBA. For as powerful as the

Dark Rock Pro 3 is, it's about as inoffensive to the ears as possible. Clips are included to let you add a third fan, if you dare.

Swathed in dark nickel plating and sporting a brushed aluminum top cover, the Dark Rock Pro 3 is as much a stunning sculpture as it is a dangerously effective cooler. What's not to like? ■

## Dark Rock Pro 3

\$89.90

be quiet!

[www.bequiet.com](http://www.bequiet.com)

## SPECS

Materials: Copper (base, heatpipes), aluminum (fins); Fans: 1 120mm, 1 135mm fan; Heatsink dimensions: 6.4 x 5.2 x 4.8 inches (HxWxD); Socket compatibility: Intel LGA775/1150/1155/1156/1366/2011(v3), AMD 754/939/940/AM2/AM2+/AM3/AM3+/FM1/FM2/FM2+; 3-year warranty




**PNY**

# XLR8 16GB DDR3-1866

PNY's memory kits have been a popular choice in recent *CPU System Workshop* builds, as they provide impressive performance without breaking the bank. For Sweet Sixteen, we went with PNY's XLR8 16GB DDR3-1866 (model number MD16384KD3-1866-X9), a kit that includes two 8GB modules. The high-capacity modules fill up only two of DIMM slots on our Z97 motherboard, so the lucky winner at PAX East has some flexibility to maximize the mainboard's capacity down the line.

This kit's performance is what we've come to expect from PNY. Besides the speedy 1,866MHz frequency, the XLR8 16GB DDR3-1866 kit uses the fast timings of 9-10-9-27 at 1.5V. The modules' low latency ensures that Sweet Sixteen responds quickly, even when performing demanding tasks. The XLR8 heat spreader helps PNY to achieve the aggressive timings by efficiently dissipating heat away from the memory modules. The low-profile heat spreader is also helpful in maintaining spatial harmony with our system build's large CPU air cooler.

This RAM looks like it's made for our build, thanks to the black heat spreader that matches the black PCB and DIMM slots on our motherboard. Setup was a breeze, too, because PNY makes these modules Intel XMP-ready. It only took a moment in our motherboard's BIOS to select the XMP 1866MHz profile to optimize the memory for maximum performance. Best of all, PNY backs its memory with a lifetime warranty—not that we expect to run into any issues with this kit.



In the *CPU System Workshop*, we strive to avoid performance bottlenecks, and the XLR8 16GB DDR3-1866 kit should make certain that we won't see any issues with memory performance. The dual-channel kit features modules that are both high-capacity

and high-performance. Only the best for our Sweet Sixteen. ■

**XLR8 16GB DDR3-1866**

\$159.99

PNY

[www.pny.com](http://www.pny.com)

## SPECS

Capacity: 16GB (2 x 8GB); Timings: 9-10-9-27; Frequency: DDR3-1866 (PC3-14900); Voltage: 1.5V; Unbuffered; Non-ECC; Lifetime warranty


**ENERMAX**

# Thormax GT

As far as the enthusiast intelligentsia is concerned, if your system doesn't make a good first impression it might as well make the worst impression. But an eye-catching exterior is practically worthless if the case's interior doesn't have a layout that lets you neatly install your components. It also doesn't hurt if the case is built for expandability. No pressure, right?

ENERMAX's Thormax GT happens to meet all the above job requirements. Stylish on the outside and intelligent on the inside, the Thormax GT aced its interview, and we put it to work immediately.

Although it's designed to accommodate serious hardware, the Thormax GT knows how to have fun. Of the three pre-installed fans, two are ENERMAX's T.B. Vegas blue LED units. You'll find one tucked behind the front panel, while the other is mounted to the left side panel. The T.B. Vegas fans have the following five light settings: Vegas, Sparkle, All on, Flash, and Off. These fans measure 180mm, and the Thormax GT also includes a plain black 120mm rear exhaust fan. A four-speed fan controller at the front of the top panel lets you adjust the fans' RPM, and an LED light controller can set the fans' LED brightness anywhere from stealth to Griswold.

The Thormax GT doesn't force you to compromise over components. Its cavernous interior has enough room for motherboards up to E-ATX, graphics cards up to 14 inches long (or 19 inches long if you remove the top drive cage), 360mm radiators, and as many as five

2.5/3.5-inch drives. There are also four 5.25-inch external bays. Rubber-grommeted cable management holes line the perimeter of the motherboard tray, so all that top-shelf hardware will be easy to install and keep tidy.

Amenities abound. You get a collapsible headset holder that's magnetic, so you can actually attach it to the case where it's most convenient. The Thormax GT's feet rotate 360 degrees, so it's quite sturdy when you need to perch it atop a LAN party table. And speaking of LAN parties, the back of the Thormax GT has a carrying handle that makes transport considerably easy for a case of this size.

It's big. It's bright. The Thormax GT is a monster, but it's our monster. This monster's for hire, too, so keep it mind



when you're ready to build the system of your dreams. ■

**Thormax GT**
**\$159.99**
**ENERMAX**
[www.enermaxusa.com](http://www.enermaxusa.com)

## SPECS

Dimensions: 22 x 10.4 x 21.5 inches (HxWxD); Materials: SPCC steel; Motherboard support: microATX, ATX, E-ATX; Drive bays: 4 x 5.25-inch external, 5 x 2.5/3.5-inch internal, 1 x 2.5-inch internal; Fans (included): 1 x 180mm LED front, 1 x 120mm rear, 1 x 180mm LED side; Fans (optional): 1 x 180mm or 1 x 200mm front, 3 x 120mm or 2 x 140mm or 1 x 180mm top, 1 x 120mm or 1 x 140mm rear, 2 x 120mm bottom, 1 x 180mm or 1 x 200mm side; Ports: 2 USB 3.0, 4 USB 2.0, audio I/O





AEROCOOL

# Touch 2100

Admittedly, we tend to focus on power and performance in the *CPU System Workshop*. When we give these screaming machines away, we want the winners to feel like we packed a whole lot of muscle inside. We're not saying aesthetics are unimportant—we try to keep our builds looking good, too—but given the choice between form and function, we put an emphasis on the latter. That said, the best components ask the question, "Why not both?" That's why Aerocool's Touch 2100 the perfect addition to our Sweet Sixteen build.

The Touch 2100 is large, and it puts power users in charge. It occupies a pair 5.25-inch bays but definitely puts that space to good use. The Touch 2100's 5-inch LCD touchscreen is simply glorious. We love the digital readout, and you can choose from seven colors (red, green, yellow, blue, light blue, purple, and pink). The impressive palette guarantees the Touch 2100 will match any build theme, whether that happens to be "Warhammer 40K" or "My Little Pony." Aerocool surrounds the gorgeous touchscreen with a sleek, brushed aluminum bezel, so the Touch 2100 looks great from corner to corner.

Once you finish gawking at the screen, you'll see that it can display a wealth of information about your PC's fans and component temperatures. The Touch 2100 displays the speed of up to five connected fans (although as each channel supports up to 25W, we imagine you could daisy-chain several fans to each of the Touch 2100's connectors). And of course, the Touch 2100 gives



you extensive control over the fan(s) connected to each channel, which is just the ticket for anyone who likes having a lot of dials to turn.

The Touch 2100 also has five temperature probes at its disposal. In addition to being able to keep a close eye on a whole host of component temps, you can also configure the Touch 2100 to sound the alarm whenever one of the probes detects a temperature beyond a user-defined threshold. Each fan controller is tied to a probe; if the probe triggers the alarms, the Touch 2100 will crank up the fan(s)

associated with that temperature probe to 100%. Any power user who likes to push components to the limit will tell you this is a handy feature to have.

All of this is to say that Aerocool's Touch 2100 is more than a pretty face. It'll contribute to your system's "wow" factor, sure, but it's also one of the most useful accessories you can install. ■

## Touch 2100

\$69.99

Aerocool

[www.aerocool.us](http://www.aerocool.us)

## SPECS

Fan connectors: 5; Temperature monitors: 5; Ports: 2 x USB 3.0, audio I/O; Screen: 5-inch color LCD; Front panel size: 2 x 5.25-inch bays





MSI

# Z97 GAMING 7

Motherboard manufacturers have had plenty of time to play with Intel's Z97 chipset, and they've put that time to good use. We've seen so many boards that are jam-packed with innovative, unique, and downright insanely cool features that it's difficult to keep track of them all. Then we find a motherboard like MSI's Z97 GAMING 7, which manages to give power users all of the goodies the Z97 chipset has to offer at a price that makes it accessible to a whole lot of power users. It was a proposition too good to pass up, so we decided to make the Z97 GAMING 7 the foundation of this build.

The ATX form factor Z97 GAMING 7 has everything you need to build a beastly PC. The focus here is on gaming, of course, and the Z97 GAMING 7 includes many of the same features that you'd find on MSI's pricier gamer boards. Live streamers and casters will dig that this mobo includes a bundled copy of XSplit Gamecaster, software that records your gameplay and can broadcast it live over a variety of services, such as Twitch and hitbox. With a webcam, you can simultaneously stream yourself delivering the blow by blow of your latest match.

Of course, it's the hardware that we're really interested in, and the Z97 GAMING 7 has it in spades. Equipped with a trio of PCI-E 3.0 x16 slots, the motherboard supports 2-way CrossFire/SLI (x8/x8) and 3-way CrossFire (x8/x4/x4). The motherboard's four DIMM slots can handle up to 32GB of DDR3, and you can install modules clocked up to 3,300MHz (which is almost as fast as DDR3 will ever go, now that the industry is making way for DDR4). The Z97 GAMING 7 is also ready for next-gen



**Z97 GAMING 7** | \$169 | MSI | [us.msi.com](http://us.msi.com)

solid-state drives, thanks to an M.2 slot that operates over the PCI-E bus for throughput up to 10Gbps; it's located between the bottom two PCI-E x16 slots.

You can find several little bonuses on the Z97 GAMING 7 that should help your games run and sound better. The motherboard is equipped with a Killer E2200 networking controller, which puts videogame and chat traffic in the fast lane to crush in-game stutter and client-side lag. A pair of integrated headphone amplifiers can drive up to 600-ohm loads, so that \$200+ set

of cans will sound the way the manufacturer intended. (The rest of the Z97 GAMING 7's onboard audio, collectively named "Audio Boost 2" is terrific, as well.) The MSI GAMING APP can deliver a quick, hassle-free overclock to your CPU and graphics card, scoring you a few extra fps even if your overclocking skill is nonexistent.

Thanks to things like MSI's Military Class 4 components and Click BIOS 4, the Z97 GAMING 7 is a great option for any enthusiast. At \$169, it's a great option at a great price. ■

## SPECS

Max memory: 32GB (DDR3-1600, DDR3-3300 max OC); Slots: 3 x PCI-E 3.0 x16, 4 x PCI-E 2.0 x1;  
Storage: 1 x M.2, 8 x 6Gbps SATA; Rear I/O: 1 x PS/2, Clear CMOS, 1 x Gigabit Ethernet, 8 x USB 3.0, 2 x USB 2.0, 2 x HDMI, 1 x DisplayPort, 1 x optical S/PDIF, audio I/O



INTEL

# Core i7-4790K

The Haswell architecture has reigned over the realm of desktop CPUs for the better part of two years—mighty impressive, when you think about it. We should be getting another processor architecture from Team Blue at some point this year, but for now, Haswell still rules the roost. The CPU we decided to install in this system build is the Core i7-4790K; code-named “Devil’s Canyon,” the 4790K is Intel’s Haswell microarchitecture that’s been doused with hot sauce.

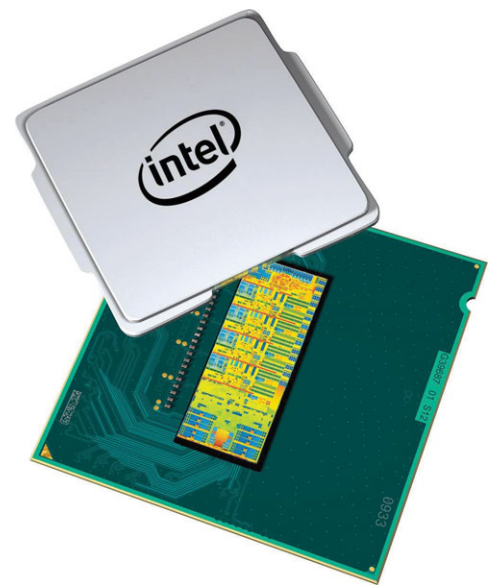
Some of that hot sauce helps keep the 4790K a little cooler than its predecessors, especially if it’s overclocked. Specifically, we’re talking about Intel’s state-of-the-art Next-Generation Polymer Thermal Interface Material, or NGPTIM if you’re not into the whole brevity thing. NGPTIM sits between the processor’s die and its integrated heat spreader. Prior to Devil’s Canyon, enthusiasts discovered that previous generations of CPUs used a TIM that wasn’t quite as robust at higher temperatures, leading them to delid their CPUs, or pry off the integrated heat spreader and apply their own TIM. This process improved overclocking performance at the expense of the processor’s warranty. Intel designed its NGPTIM to obviate the need to delid the 4790K. It’s a great move, not only because it should let overclockers go wild but also because it shows Intel is tuned in to the enthusiast community as is willing to dedicate time and effort to address its feedback.

This processor has a few more improvements that overclockers will surely appreciate.

Compared to earlier Haswell processors, the 4790K includes even more capacitors, which help make power delivery to the die as smooth as possible. The CPU also gives you access to VCCIN, VDDQ, and DRAM voltages, letting you tweak them as you see fit.

Even without the aid of overclocking, the Core i7-4790K is one freaky-fast CPU. With a 4GHz base clock, the 4790K cruises ahead of every other Intel processor, including the mighty trio of Haswell-E Extreme Edition CPUs, on the basis of frequency alone. When the 4790K’s Turbo Boost kicks in, it ramps the clock speed up to 4.4GHz. For programs that benefit more from clock speed rather than processing cores, the 4790K’s 4GHz base clock makes it an absolute beast. That said, the 4790K is no slouch when it comes to multithreaded workloads. As a quad-core processor with Intel Hyper-Threading enabled, you can keep this chip quite busy.

All of this power is packed into a 37.5mm x 37.5mm package. Despite the fact that the 4790K hums along at a fiery 4GHz, Intel has engineered it to keep its heat under control. Thanks to a very



modest 88W TDP, the 4790K is designed to be very friendly to CPU coolers and power supplies.

As expected, this firecracker of a processor excelled when we put it to the test. The Core i7-4790K was right at home in our system, and it will work just as well in yours. ■

## Core i7-4790K

\$350

Intel

[www.intel.com](http://www.intel.com)

## SPECS

Clock speed: 4GHz (base), 4.4GHz (turbo); 4 cores; Unlocked multiplier; Socket LGA1150; Dual-channel memory; 8MB Intel Smart Cache; Hyper-Threading; Turbo Boost; 22nm; 88W Max TDP





## FRACTAL DESIGN

# Newton R3 800W

Sleek Scandinavian design isn't likely a common theme at most sweet sixteen parties, but we'll gladly welcome the understated styling of Fractal Design's Newton R3 800W into our Sweet Sixteen. We also want the Sweet Sixteen to be a quiet affair, which the Newton R3 800W accommodates with ease. Fractal Design uses low-heat-generating parts and a fan that only spins up when the temperature sensor indicates that extra cooling is needed. It's got the goods to power our high-end components, too.

The Newton R3 800W comes with all the right qualifications. It's certified for both SLI and CrossFire, as well as 80 PLUS Platinum efficiency. The power supply achieves the lofty efficiency certification with a peak efficiency (at 50% load) of 92.2% and an average efficiency of 90.66%. And because Fractal Design tests the Newton R3 Series at 50 degrees Celsius, we know that the PSU will be able to deliver a full, continuous 800 watts if temperatures start to rise.

The Newton R3 800W is a semi-modular power supply; only the 20+4-pin main power, 4+4-pin ATX/EPS CPU power, and four 6+2-pin PCI-E power connectors are hardwired, so barring a dual graphics card setup, you will at most have two superfluous cables to tuck out of the way. If you need extra CPU or GPU power connectors, on the other hand, Fractal Design tosses in an 8-pin EPS connector and two 6+2-pin PCI-E connectors via modular cables. Nine SATA power connectors and four Molex power connectors are provided via the remaining modular cables. Fractal Design even bundles



Velcro cable ties and zip-ties to help keep everything civilized in our build's interior.

In terms of power distribution, Fractal Design uses a single +12V rail that can handle up to 66A. In its current configuration, Sweet Sixteen only sports one graphics card, but the Newton R3 800W's maximum amperage ensures that the lucky winner at PAX East will easily be able to upgrade to an SLI or CrossFire setup, should they get the itch. The +3.3V and +5V rails each support up to 20A for a combined maximum output of 100 watts.

The Newton R3 800W provides our Sweet Sixteen with clean power, as well as a modular design for a clean interior. We also feel good about the unit's 80 PLUS Platinum efficiency, as we know the PSU's power won't go to waste. No doubt, it's a worthy addition to our build. ■

### Newton R3 800W

\$189.99

Fractal Design

[www.fractal-design.com](http://www.fractal-design.com)

### SPECS

Maximum wattage (continuous): 800W (at 50 C); 12V rails: 1 (66A); +5V max: 20A, +3.3V max: 20A; Efficiency rating (advertised): 92% typical; Fan: 135mm; Connectors: 1 x 20+4-pin ATX, 1 x 4+4-pin ATX/EPS12V, 1 x 8-pin EPS12V, 6 x 6+2-pin PCI-E, 9 x SATA, 4 x Molex, 1 x floppy; Warranty: 5 years





# Sweet Sixteen Posterizes Our Benchmarks

At this point, we've come to know the components used in this installment of *CPU System Workshop* so well that we can predict the outcome of our benchmark testing with the precision of a Las Vegas oddsmaker. Still, that doesn't mean it's any less fun to gather together an assortment of enthusiast-grade hardware, put together another insane rig, and let it run wild.

The system's Intel Core i7-4790K and factory-overclocked MSI GTX 970 GAMING 4G LE gave us a solid foundation, producing excellent baseline results. Sweet Sixteen exceeded 5,000 points in 3DMark's Fire Strike Extreme test. Its performance in our two real-world game tests was just as impressive. In both *Aliens vs. Predator* and *Metro: Last Light*, we almost averaged 50fps; considering we run these tests at a grueling 2,560 x 1,600 resolution with several quality settings cranked up, the always highly sought-after 60fps average should be well within reach with slightly reduced settings or resolution. Or, if you win this system, you could simply add another GTX 970 and sacrifice nothing.

Sweet Sixteen performed well in our CPU-intensive benchmarks at its stock 4GHz clock speed, but it performed even better when we overclocked it. After setting the CPU voltage to 1.29V (the MSI Z97 GAMING 7's Click BIOS 4 makes this step easy), we were able ratchet up the 4790K's frequency to 4.7GHz. Afterward, we saw immediate and obvious gains in any test that taxed the processor. So,

whether it's gaming, encoding, or any other demanding task, this PC does it and does it well.

Crucial's 500GB MX200 was definitely the right choice, doing to

CrystalDiskMark what the 4790K and GTX GAMING 4G LE did to our respective processor-intensive and GPU-intensive benchmarks. It slammed the sequential tests and rocked the



## SPECS

Processor: Intel Core i7-4790K; Motherboard: MSI Z97 GAMING 7; Graphics card: MSI GTX 970 GAMING 4G LE; RAM: 16GB PNY XLR8 DDR3-1866; Storage: 500GB Crucial MX200; PSU: Fractal Design Newton R3 800W; CPU cooler: be quiet! Dark Rock Pro 3; Case: ENERMAX Thormax GT; Fan controller: Aerocool Touch 2100; Windows 8.1 Pro





4K random tests, too. And any time the MX200 is able to feed on several simultaneous data requests, its random performance will be even better, as evidenced by CrystalDiskMark's QD32 random tests.

Like any five-star prospect, Sweet Sixteen has intangibles, too. As we tested the system, several of us remarked that this was one of the quietest systems we've built for the *CPU System Workshop*. And although there's no way to test it, the DXRacer Formula Series chair was unbelievably comfortable, leaving us more than a little depressed to return to our pedestrian office chairs.

The final buzzer has sounded, and there's no doubt: Sweet Sixteen shatters the glass. ■







Benchmark Results	Sweet Sixteen (stock)	Sweet Sixteen (4.7GHz)
<b>3DMark Fire Strike</b>	<b>5057</b>	<b>5140</b>
Graphics Score	5268	5346
Physics Score	12389	12590
<b>PCMark 8</b>		
Creative Score	4844	4992
<b>Cinebench 15</b>	<b>875</b>	<b>930</b>
<b>POV-Ray 3.7 Beta (pixels per second)</b>	<b>1830.97</b>	<b>1940.97</b>
<b>SiSoftware Sandra 2015</b>		
Dhrystone AVX2 (GIPS)	190.78	205.4
Whetstone AVX (GFLOPS)	120	130.29
Multi-Media Integer x32 AVX2 (Mpixels per second)	337.31	348.5
Multi-Media Long-int x16 AVX2 (Mpixels per second)	144.3	154
Multi-Media Quad-int x1 ALU (Mpixels per second)	2.2	2.4
Multi-Media Single-float x16 FMA	318.81	343.69
Integer Memory Bandwidth B/F AVX/128 (GBps)	23	23.19
Floating Memory Bandwidth B/F AVX/128 (GBps)	23.13	23.22
<b>CrystalDiskMark 3.0.1 (MBps)</b>		
<b>Sequential Read</b>	<b>506.2</b>	<b>502.2</b>
<b>Sequential Write</b>	<b>494.8</b>	<b>482.2</b>
512KB Random Read	445.2	436.6
<b>512KB Random Write</b>	<b>483.7</b>	<b>472</b>
<b>4KB Random Read QD1</b>	<b>32.39</b>	<b>30.19</b>
4KB Random Write QD1	115.7	118
4KB Random Read QD32	344.5	338.12
4KB Random Write QD32	343.6	347.5
<b>Unigine Heaven</b>		
Score	1306	1312
FPS	51.7	52.1
<b>Games at 2,560 x 1,600</b>		
Metro: Last Light (16XAF)	48	48.1
Aliens vs. Predator (4XAA, 16XAF)	49	49.3



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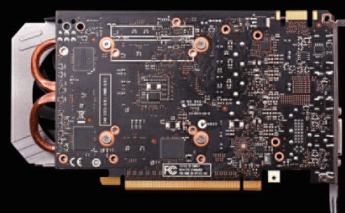
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# White Lightning

Anthony “NRP|Elmnator” Lackey’s first turn in *CPU*’s “Mad Reader Mod” feature came in the October 2011 issue and showed off a brightly colored mod called “Candy.” This month’s winner, White Lightning, is also a big, bright mod, thanks to its white finish, bright white interior lights, and chromed hard-tube cooling loop.

We’ve seen White Lightning before. It has been a finalist in more than one mod contest, including a top-five finish at PDXLAN, where the competition is legendarily tough. The mod won first place in the mod contest at LANFest InfernaLAN Spring 2014 in DuPont, Wash., in June, and went on to best all other mod contest winners from Intel LANFest events for the 2014 calendar year. That makes it this month’s Mad Reader Mod.

As you flip through these pages, you’ll see why; White Lightning is an amazing piece of work.

## What’s In A Name?

Lackey says the inspiration for the mod’s name—and its purpose—were both pretty straightforward.

“I named it ‘White Lightning’ because it’s white, and all the light bouncing off of the chrome kinda looks like lightning,” he says. “I built this thing for speed and power. I needed it to run five ASUS VG248QE 144MHz monitors, running at an overall resolution of 5,400 x 1,920.”

To that end, Lackey secured a pair of Club 3D Radeon R9 295X2s (for a total of four GPUs) and overclocked them to

1,076/1,348MHz. He also overclocked the system’s Intel Core i7-4770K to 4.8GHz and configured a pair of ADATA SX900 128GB SSDs into a single RAID 0 boot volume.

## Let’s Go To Work

White Lightning began with an AZZA Genesis 9000; Lackey gutted it, removing all black pieces so that all that was left were the white bits and blue accents here and there. Then he enlarged the side panel window (“I did this with just a Dremel and a steady hand,” Lackey tells us), chrome-plated a pair of triple rads, chrome-plated an ASUS Xonar Essence STX sound card, painted his PSU and the armor on his ASUS motherboard white, painted his SSDs white and added custom vinyl logos to them, and sleeved all of his power supply’s cables in white and blue.

Lackey also spent a considerable chunk of time and effort on the system’s five monitors. He debazelled each one in favor of the thinnest frames he could get in order to keep the gaps in his picture as small as possible.

## Roll Call

We mentioned a few of the parts Lackey built into White Lightning above, but here’s the complete rundown: An Intel Core i7-4770K socketed in an ASUS SABERTOOTH Z87 motherboard, Crucial Ballistix Tactical Tracer DDR3-1600 memory, the aforementioned Club 3D R9 295X2s, a Corsair AX1500i power supply, his ADATA SSDs, and the AZZA





case. Lackey built his cooling loop from EK GPU blocks, XSPC radiators, an EK reservoir, a Koolance CPU block, and 16 ENERMAX T.B. Vegas fans (white, of course).

Lackey sends thanks to Club 3D, EK, AMD, ADATA, and AZZA for their contributions to White Lightning, and an extra special thanks to his wife Melissa for always being there and supporting his hobby.

"Last but not least," Lackey says, "I want to get a shout out to my clan NRP (Nerd Rage Pros) for being supportive and being such a great group of people that are fun to hang out with."

### Candy, Lightning, ???

We're not exactly sure what comes next in this series, but Lackey says he's begun his next mod and hopes to have it done in time for PDXLAN 26 in July.

"It's an all-copper tubular frame with candy-apple red panels with gold flakes," Lackey says.

You can bet we'll be keeping an eye out for it. ■

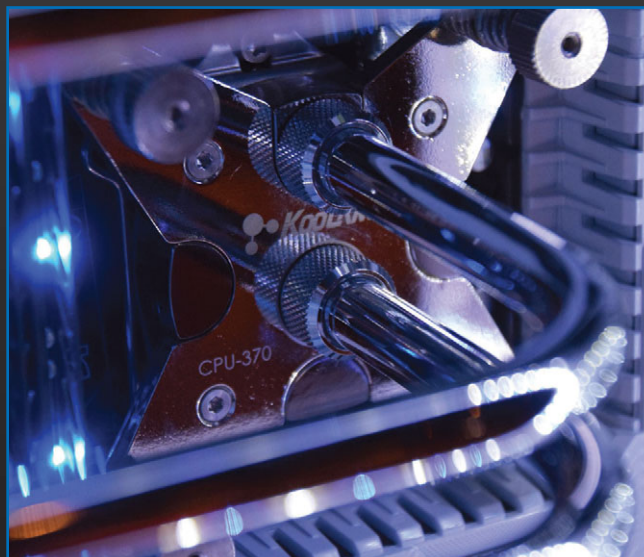


## We Want Your Mod

Have a computer mod that will bring tears to our eyes? Email photos and a description to [madreadermod@cpumag.com](mailto:madreadermod@cpumag.com). If we choose your system as our "Mad Reader Mod," we'll send you a cash prize and a one-year subscription to *CPU*. (U.S. residents only, please.)

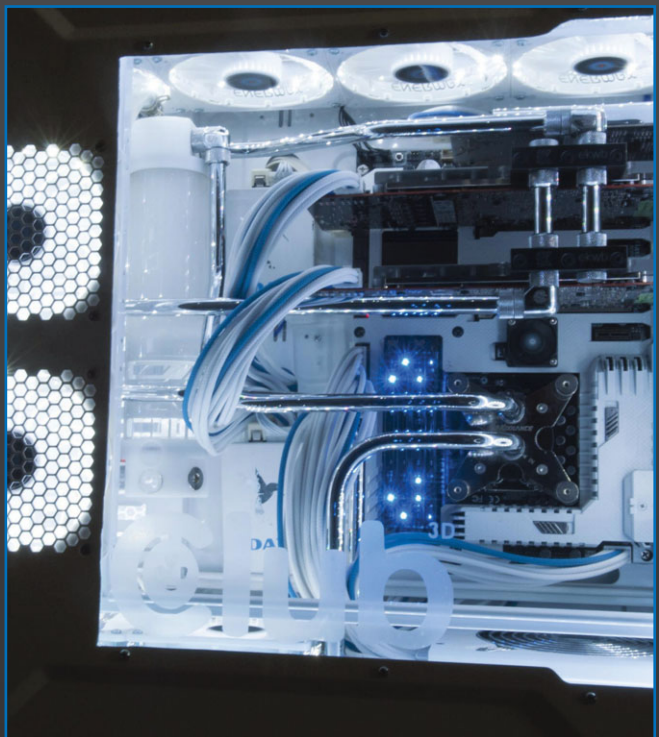
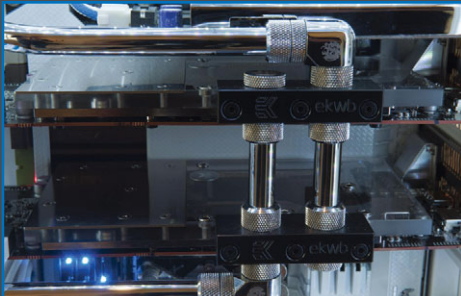


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## PAX South 2015

# The Biggest Gaming Con Gets A Little Bigger

In late January, *CPU* hit the road for San Antonio, Tex. to attend the inaugural PAX South. Prior to the event's announcement, PAX had two massive North American events serving enthusiast gaming communities on the East and West Coasts, and each one routinely sells out within weeks of announcing ticket availability. Audiences on the other side of the world also get their game-con fix at Melbourne's PAX Australia. But for those first-time attendees in the south-central United States, having a PAX so close to home was simply irresistible.



As one of the 120 exhibitors at the show, we immediately noticed a few things that made PAX South stand out from the most recent PAX East and PAX Prime events. Although there were fewer exhibitors and attendees at this event, PAX South beat the inaugural attendance totals for both PAX East and PAX Prime. All told, an estimated 40,000 gaming fans flooded the Henry B. Gonzalez Convention Center for the three-day event to get hands-on with new games, meet industry movers and shakers, and celebrate gaming culture with a crowd of like-minded peers.



Although PAX South was a smaller event compared to the more established PAX shows, there was no dearth of excitement on the show floor from attendees excited about PC gaming and vendors looking to engage with them. Judging by the fan reaction alone, we'd say San Antonio was a prime choice, and we apparently aren't the only ones left with that impression; according to the *San Antonio Express-News*, PAX South will be coming back to Texas at least through 2017.



## PAX South Declassified

The larger PAX shows of late have begun to resemble industry PR events, such as E3, with large game publishers, console manufacturers, and AAA development studios taking the opportunity to make announcements and launch products. PAX South, on the other hand, had few, if any, of those high-profile reveals; Sony and Microsoft were absent (though Nintendo was showing off the New 3DS XL); and arguably the biggest announcement was a new playable character for Gearbox's *Borderlands: The Pre-Sequel*.

The scarcity of big publishers and hardware vendors at PAX South did mean that there were a lot of attendees eager to see and do everything the show had to offer, and for the first time in recent memory, an attendee with a single-day pass could conceivably make a stop at every booth, play a dozen game demos, and even hit a panel discussion or two before the event closed its doors for the night.

A big fan of games himself, *CPU* Editor Chris Trumble made the most of his three-day pass. "The expo was much smaller than those we've seen at PAX Prime and PAX East and included very few major publishers/developers. But attendance was strong, and there were big lines for game demos around the floor."

One of the more popular events was Gearbox's Iron Cosplay Extravaganza. The contest pitted two teams of cosplay costume creators against each another using only a random collection of supplies.

As ever, Gabe and Tycho's traditional PAX Q&A session was a big highlight. "The guys answered pre-collected questions and touched on topics such as the nature of their relationship outside of work, the number of PAX events, and various aspects of their daily lives."



San Antonio afforded attendees plenty of other recreational opportunities around the Henry B. Gonzalez Convention Center, such as this romantic gondola ride for 25.



(Left) We found this impressive system from NCIX on the show floor. If you go to PAX East, hit the Intel booth and say hello to the builder, Ivan.

(Above) Three intrepid gladiators battle tirelessly to entertain their caffeinated citrus soft drink overlord.



## Lookin' Good

On Saturday, we scouted out the Intel-sponsored PC freeplay area, which consistently had long lines of attendees waiting to get a shot at the latest PC games. But the adjacent BYOC was the real reason we stepped away from the show floor. It was time to take in some mods.



Later that night, we awarded top honors in the mod contest to Christopher Stolze for his Hammer X99 mod, which featured some slick red vinyl work, an attractive handmade PSU cover, impeccable wiring, and a gorgeous custom-built liquid-cooling system.



There were two runners-up, the first was RogerX, for his vintage Silvertone radio mod, and the second was Blake, for his liquid-cooled In Win D-Frame Mini.



Blake's In Win D-Frame Mini looks sharp in red and black.



Everybody wins at the PAX South Intel LANFest. Intel was generous enough to offer the winning modders a 240GB Intel 730 Series SSD, GIGABYTE Z97-HD3 motherboard, and an Antec KÜHLER H2O 1250. (Of course, a thank-you is also in order to GIGABYTE and Antec for supplying the additional prizes.)



## We Come Bearing Gifts

For us at the booth, PAX South consisted of a steady stream of people who shared our love of gaming and the machines we use to play them. PAX South's decidedly measured pace gave us the opportunity to get a lot of face time with attendees, and we had more than a few engrossing discussions on such varied topics as mineral oil submersion, hardline tubing in PCs, what makes a decent power supply, how to break into PC modding, and how big your frame buffer should be.



CPU, with the help of a host of sponsors, made the first PAX South very memorable for Brandon, the (very) lucky winner of the PAXbox.



Many entered, but only a few (or rather, one) won the PC we built just for this event.

The CPU System Workshop's PAXbox build was another conversation starter. We let people test its performance by playing *Alien: Isolation* and *Metro: Last Light*. We also showed off Creative Labs' Sound Blaster X7, which is a unique external sound card that brings audiophile-quality tunes to your PC, tablet, smartphone, passive speakers, and more. On Saturday, Robert S. was holding the winning raffle ticket. He had recently built a new PC and said he was looking forward to adding the Sound Blaster X7 to his system. On Sunday, Brandon S. was floored when he won the PAXbox gaming system featured in the January 2015 issue. Brandon had built a new system a year ago but admitted that the PAXbox was a massive upgrade in every way.

We'd like to thank all of the build sponsors, including Aerocool, Intel, GIGABYTE, EVGA, ADATA, Firepower Technology, Thermaltake, and GX Gaming for making our PAX South giveaway such a monumental success.



Robert S. assured us that he can handle the 24-bit 192kHz audio the Creative Labs' Sound Blaster X7 pumps out, so we let him take it.



Cases



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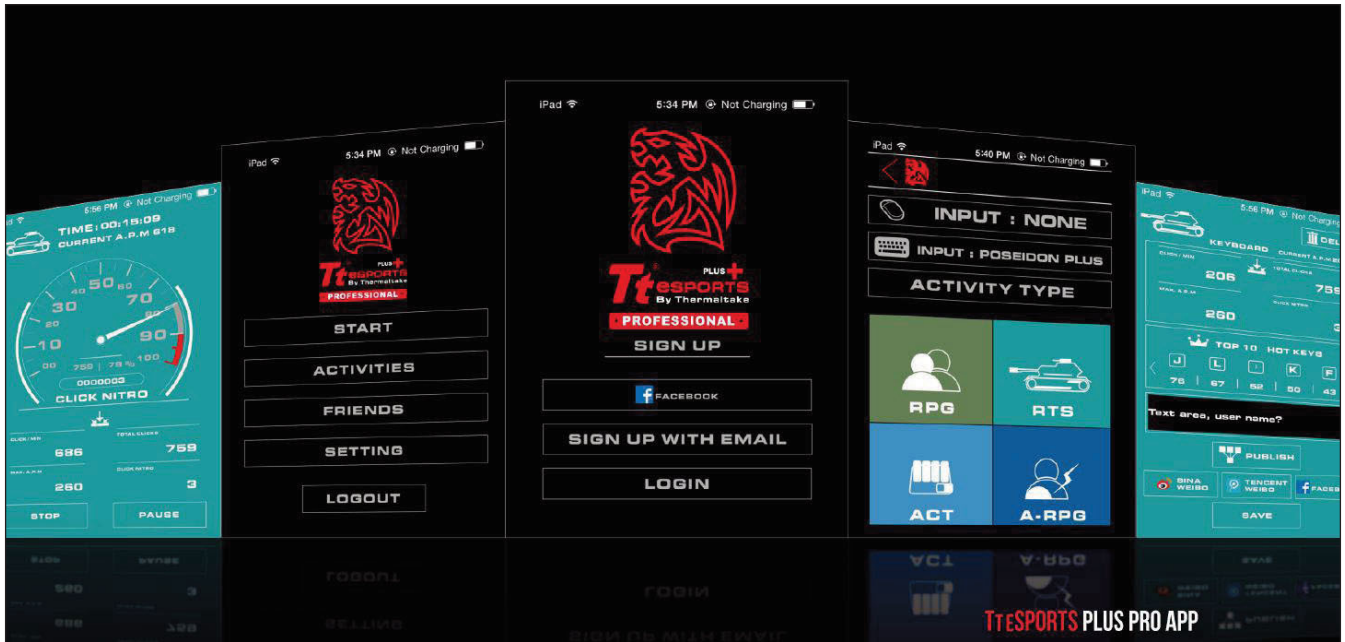
## ***10 years of cooling, over 20 years of power.***

Enermax celebrates its anniversary with tremendous honor and pride, consistently delivering only the highest quality PC components and products. With top tier engineers in its R&D teams, Enermax continues to make waves across the forefront of the PC hardware industry with countless innovations and patents. "Technology Innovation" and "Quality First," have always been the very essence of the products and brand value, which have been proven over the years with numerous awards and recognition from worldwide reviewers, professionals, and more importantly, the fans.



# A Smarter Way To Play

## Tt eSPORTS Peripherals Deliver Real-time Analytics



Tt eSPORTS SMART SERIES peripherals can connect to your mobile device and the Plus+ Professional app to capture actions per minute and other input-related stats.

Analytics are a driving force in modern sports. The NBA, for example, tracks player and ball movement to give fans and coaches new ways to evaluate hoopsters, and baseball experts often use sabermetrics to compare the value and skills of different players. With its SMART SERIES peripherals, Tt eSPORTS brings analytics to your PC gaming. You can record keyboard and mice usage stats and view total clicks, clicks per minute, lift off count (for mice), distance per minute (for mice), and top 10 hotkeys (for keyboards), among others. “The data allows you to have a true numerical representation of your gameplay performance, and this can be used in various ways, such as being able to track improvements in speed over time,” says Thermaltake marketing manager Shannon Robb. Let’s take a closer look at how Tt eSPORTS’ SMART SERIES peripherals

work and how the data they provide can improve your game.

### Making Use Of Big Data

“Everything today is connected,” says Robb. “Wearables, headgear, and appliances are connected to give you data feedback and help you make life better.” Similar to today’s modern IoT devices, Tt eSPORTS SMART SERIES peripherals do more than just monitor input stats. The data is uploaded to the Tt eSPORTS PLUS+ Community and its Data Management Platform, where you can delve deeper into the stats for further analysis. Robb says “When you integrate the Tt eSPORTS PLUS+ community, you can compare gameplay statistics with others, including pro players, to see how you match up.” What better way to know if your game skills are equal to the pros?

The Data Management Platform gives you a place to store your stats, too. This way, you can break down click stats over time to track improvements. “Gaming has been a bit behind the curve in terms of finding ways to teach gamers how they play and maybe use the metrics to learn how they can improve,” says Robb. SMART SERIES devices could prove to be a new way to gain a competitive advantage.

The collected stats are more than just how fast you type or quickly you click. “One of the really cool features is the ability to track your most commonly pressed keys,” says Robb. “The top 10 can be displayed to help you find hotkeys that maybe you don’t notice you use a lot—or that are farther away from your other main hotkeys—which can then be remapped to eliminate unnecessary hand travel that slows down action.”



which allows the keyboard and mouse to communicate with your smartphone or tablet. And when combined with the Tt eSPORTS Plus+ Professional app, your mobile device can log and upload the statistics to the Tt eSPORTS Plus+ Community, so you can compare your numbers to others. The Plus+ Professional mobile app is currently available for iOS, and an Android version is coming soon.

To get started, open the app and connect with your SMART SERIES peripheral. Next, you'll select the genre of the game you will be playing, such as RPG, RTS, or FPS, to properly categorize the stats. Once logging data, the Plus+ Professional app will display live stats and charts, which is great for those who want real-time analytics. With the THERON Plus+ SMART MOUSE, for instance, the app logs clicks per minute, distance traveled, and lift-offs. Other available mouse stats include max APM, total distance, and total actions. On the POSEIDON Plus+ SMART KEYBOARD, you can see APM, total actions, and top 10 hotkeys.

For further analysis, you can log into the Tt eSPORTS PLUS+ Community ([plus.ttesports.com/en](http://plus.ttesports.com/en)). Here, you can view of history of your activities and reports with all your performance statistics. The clicks, keypresses, and mouse movements logged via your SMART SERIES devices also earn you Dragon Points, which you can redeem at events created by Tt eSPORTS. You can

The THERON Plus+ SMART MOUSE is the first mouse in Tt eSPORTS SMART SERIES.

Robb points out a couple of tactical benefits for the smart mice, too. "The ability to track things, such as your lift-off count, will show when you are readjusting your hand position or resetting your mouse because you went too far off the pad or near the edge," says Robb. Based on the data, you can adjust your play style to spend less time lifting the mouse and more time working on precision in-game movements.

You can also compete with friends. "The Tt eSPORTS PLUS community allows users to share their gaming analytics with other users, as well as challenge friends or other community members for points," says Robb. "Some of these features are still being implemented and improved, but there are vast plans to allow challenges, competitions, and even comparisons between our pro players and other users for possible points or even just to learn some cool info about their favorite player and how they play."

Tt eSPORTS only recently released the SMART SERIES line of peripherals, so Robb expects that users will find many more great uses for the data. "So far, I would say that things like the lift-off count and APM (actions per minute) races have

been cool stats to compare," says Robb. There's also a social aspect to the SMART SERIES peripherals, so you can share key metrics via Facebook and Twitter.

### How It Works

Tt eSPORTS introduced the SMART SERIES capabilities on its POSEIDON Z Plus+ SMART KEYBOARD and THERON Plus+ SMART MOUSE. What makes these peripherals so "smart" is their integrated Bluetooth 4.0 capability,



In addition to its SMART SERIES connectivity, the POSEIDON Plus+ SMART KEYBOARD comes with lots of great gaming features, including Tt eSPORTS Certified Blue mechanical switches.





When connected to the THERON Plus+ SMART MOUSE, the Tt eSPORTS Plus+ Professional app will display real-time stats, such as current and max actions per minute.

view these achievements in the Tt eSPORTS PLUS+ Community, as well as wager your Dragon Points in challenges. In other words, sometimes there's more than just pride on the line if you challenge someone.

### A Weapon Worthy Of POSEIDON

The ability to monitor and review keypresses is a compelling feature, but it would mean little without a keyboard that meets the needs of serious gamers. "The POSEIDON Z Plus+ SMART KEYBOARD at its base level is a POSEIDON Z keyboard, which has been built from the ground up to be an awesome, reliable, and all-around excellent keyboard," says Robb.

With its POSEIDON Z Series, Tt eSPORTS spent two years testing mechanical switches with its engineers and professional gamers. "We had searched and tested a huge amount of mechanical keyboard switches trying to find the one that meets not only our performance, but the quality standards to bear the Tt eSPORTS Certified seal," says Robb. "Working with user feedback, we learned where the best compromise for feel, audibility, and response was for most users and that's where we started."

The POSEIDON Z Plus+ SMART KEYBOARD boasts the Tt eSPORTS

Certified Mechanical Blue switches, which provide you with both tactile and audible feedback. The Blue switches feature an actuation force of 60 grams, as well as a trigger travel distance of 2mm. Tt eSPORTS rates its Certified Mechanical Blue switches for a lifespan of 50 million keystrokes and backs the keyboard with a five-year warranty.

Besides the tactile feedback, this 104-key, full-sized keyboard also provides you with blue LED backlighting. You can adjust the LED brightness level, and the keys also support pause-break effects. A set of preconfigured lighting zones is also stored on the keyboard, which you can load up if you only want to illuminate the most critical keys.

To prevent key ghosting, the POSEIDON Z Plus+ SMART KEYBOARD supports full N-key rollover via USB. Another clever addition is the Windows key switcher that changes the Windows key to a CTRL key. This way, you can lengthen the CTRL key and enjoy a little more leeway when hammering the "fire" button.

Best of all, Tt eSPORTS offers the POSEIDON Z Plus+ SMART KEYBOARD at \$99.99. There are many full-size mechanical keyboards that retail for well above this price range, and these

models don't come with all the connected goodies found on the POSEIDON Z Plus+ SMART KEYBOARD.

### The Smartest Mouse

Tt eSPORTS' THERON mice have long been a popular choice among gamers, thanks to precision hardware and customizable software. The THERON Plus+ SMART MOUSE features an AVAGO laser sensor (the ADNS-9800) that supports on-the-fly DPI adjustment from 50dpi to 8,200dpi.

Similar to the technology on the POSEIDON keyboard, Tt eSPORTS selected the THERON Plus+ SMART MOUSE sensor based on input from experts. "We test multiple variations of components," says Robb. "Our pro players, along with internal testing and engineering teams, used different play types to find out which combinations of components provided the most desirable gaming experience."

You'll also be able to configure the mouse any way you want. Robb says "The THERON Plus+ SMART MOUSE has the full GUI interface, same as our other THERON mice, which allows full adjustability of profiles, DPI, polling rates, lighting, and lift-off distance to allow the mouse to better fit the style of play you

need.” The configuration options are ideal for gamers who want to precisely calibrate the mouse. For example, the adjustable lift-off capability can help to reduce Z-axis tracking problems that might cause rapid mouse movement during lift-off.

This smart mouse lets you program four DPI levels (at 50dpi increments), and you can switch the DPI on-the-fly using the up and down buttons behind the scroll wheel. When switching among the programmable DPI levels, an LED on the left side of the mouse will indicate the current DPI level in use. For further precision, you’ll also be able to adjust the mouse’s polling rate among 125Hz, 250Hz, 500Hz, and 1000Hz, if you prefer not to use the fastest polling rate.

Gamers who play a wide variety of genres will like that Tt eSPORTS allows you to create up to five user profiles, which can hold up to 40 programmable macros. In addition to the macros, each profile can have up to four programmable

## Mobile Device Compatibility

The SMART SERIES peripherals connect to your mobile device via Bluetooth. Those with an iOS device will need to be running iOS 7.0 or later. For Android devices, Tt eSPORTS says that an app will be available soon and will likely require Android 4.3 or later.

DPI levels. The THERON Plus+ SMART MOUSE also comes with its own onboard memory, so you’ll have access to the profiles even when using the mouse with another PC. A profile button on the bottom of the mouse lets you switch the profile without the need of the Tt eSPORTS software utility.

The THERON Plus+ SMART MOUSE includes eight buttons, so

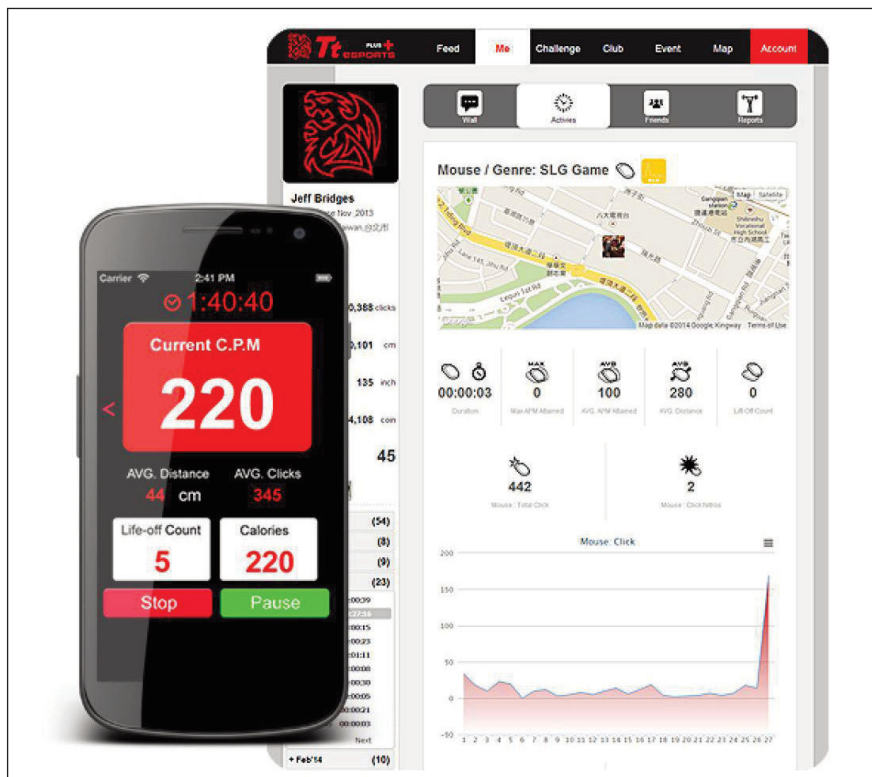
you’ll have lots of flexibility as to where you bind the macros. Besides the standard left, right, and scroll wheel buttons, you’ll also have two thumb buttons and one button near the right-click button that you can press with your ring or pinky finger. The DPI up and down buttons make up the remaining controls on the top of the mouse. On the bottom, Tt eSPORTS includes a Polling Rate button for even more fine-tuning of your gameplay experience.

Clearly, customization is a priority for Tt eSPORTS with the THERON Plus+ SMART MOUSE. Lighting is part of its modification options, too. RGB illumination lets you select among 16.8 million colors in four controllable regions (the mouse wheel, the Tt eSPORTS battle dragon logo, the left and right side panels, and the bottom panel). You can also switch between Normal and Battle mode. (In Battle mode, the mouse’s lighting will flash based on your click frequency, speeding up and slowing down in real time.)

Tt eSPORTS spent time engineering the feel and weight of the THERON Plus+ SMART MOUSE, too. There’s an adjustable weight system that lets you give the mouse just the right amount of heft. The exterior of the mouse features a glossy coating to ensure your palm won’t stick to the mouse. Tt eSPORTS uses Omron switches to provide responsive click feedback, too. No detail is too small.

## Peripherals With A High IQ

“The SMART SERIES is where we follow one of our key mission statements for Thermaltake brands, which is ‘Delivering the perfect user experience,’ going in the direction of helping provide data that can be used to make your gaming even better,” says Robb. Gamers should also like that Tt eSPORTS and its parent company Thermaltake opted to use some of its top-of-the-line options for keyboards and mice to introduce the SMART SERIES. If you’re looking for ways to take your game to the next level, the SMART SERIES is as good a place as any to start. ■



Within the Tt eSPORTS Plus+ Community, you’ll be able to check the history of your logged stats to determine how you’ve improved over time.



# Why The Pros Use GIGABYTE Hardware

## Power User Testimonials

Since its founding days in 1986, GIGABYTE has been a groundbreaking force in PC hardware. Extreme performance is one of GIGABYTE's foremost calling cards, which is why so many system builders, gamers, and overclockers the world over prefer GIGABYTE components to those of other brands. We recently spoke with two people who we think you'll agree meet all the criteria to be called experts; we asked them to discuss how GIGABYTE's components have helped them achieve blistering overlocks and create the best machines possible.

### Wallace Santos

Santos is the co-founder and CEO of MAINGEAR, a boutique computer manufacturer geared toward enthusiasts. Santos is also a lifelong gamer and enjoys tuning and modding cars. As such, MAINGEAR's specialization in cutting-edge rigs with striking looks is no surprise. In crafting the perfect PC, MAINGEAR and Santos often turn to GIGABYTE. "When MAINGEAR started in 2002, we wanted to be associated with highly respected brands, those primarily in the enthusiast sphere," says Santos. "We reached out to GIGABYTE and they have given us fantastic support ever since."

As a boutique builder, MAINGEAR also wants to make certain its systems are extremely reliable, which is where GIGABYTE's Ultra Durable technology comes into play. "GIGABYTE's Ultra Durable line of products complement our gaming PCs very well," says Santos. "When selecting parts, we take into account, quality, features, aesthetics, and durability. Ultra Durable just happens to cover all of these criteria."



GIGABYTE's powerful onboard additions also help MAINGEAR maximize the available add-on card slots. "In our high-end gaming systems, we end up utilizing all the PCI-E slots by adding three or four dual-slot GPUs," says Santos. "This leaves us with no space for extras like premium audio and networking cards." GIGABYTE's onboard audio is often supported by high-end Nichicon capacitors and Creative dedicated audio processors, so there's no need for MAINGEAR to add a dedicated sound card.

Santos finds GIGABYTE's AMP-UP Audio technology particularly useful to enhance the sound quality of MAINGEAR's systems. "It's amazing how much of a difference a built-in headphone amplifier makes, and the interchangeable OP-Amps allow you to really tune the audio to your preference," says Santos. Great onboard audio and networking also help



MAINGEAR provide the best value when tailoring a rig to meet a customer's budget and gaming preferences.

The gaming experience, of course, is about more than just raw GPU horsepower. Support for today's latest gaming hardware, such as what's found on GIGABYTE's G1 GAMING motherboards, help MAINGEAR to best meet buyers' needs. "GIGABYTE simply does not cut any corners with the G1 lineup," say Santos. "Premium aesthetics, audio, networking, onboard Wi-Fi, and amazing storage are just some of the perks."

MAINGEAR customers who select the Redline Overclocking Service expect top-notch results, and MAINGEAR often turns to GIGABYTE motherboards for ultimate performance. "The 2X Copper PCB design, gold-plated CPU sockets, server-level chokes, and POSCAP capacitors all help to provide record-breaking overlocks," says Santos. GIGABYTE's SOC Force

boards are MAINGEAR favorites. “I like to compare the SOC boards to F1 racing; it’s all about speed. When combined with our custom water-cooling solutions, we find we are able to consistently hit high overlocks.”

MAINGEAR also likes GIGABYTE’s graphics card lineup. “We like to use GIGABYTE’s NVIDIA and AMD reference design GPUs in our builds due to all the pre-qualification that is done before the product launch,” says Santos. When it comes to GPU overclocking, Santos is also a fan of GIGABYTE’s software: “I love tweaking GPUs with OC Guru II. Not only is it a great tool for changing voltage, clock speeds, and fan profiles, but it also has a monitoring tool that lets you keep track of every detail of the GPU while you’re gaming.”

The eye-catching looks of GIGABYTE components are important to MAINGEAR, too. Santos says, “One of the advantages of having a great partner like GIGABYTE is that we get the opportunity to see early designs before a board has gone into production and help make suggestions.” MAINGEAR has input on things like color scheme, chipset cooling design, and LED lighting. “GIGABYTE takes our feedback into the final design, helping to create something that really complements our systems, and elevates the design,” says Santos.

MAINGEAR’s overall experience with GIGABYTE has been exceptional. Santos sums it up thusly: “GIGABYTE has been an excellent partner from the start; we proudly offer their motherboards in our systems, which enables us to deliver amazing products.”

### Steven Bassiri

Bassiri (aka Sin0822) is an overclocker with several world-record overlocks to his credit. Now, his time spent overclocking is often geared toward teaching others how to reach peak speeds. Bassiri says “I have an overclocking guide for just about every single chipset since Sandy Bridge.” He also works with motherboard manufacturers to improve overclocking features. As such, Bassiri knows a lot about what makes a motherboard a worthy choice. “My first GIGABYTE board was an X58A-UD5 revision 2.0, and I have had a GIGABYTE board for every chipset since,” says Bassiri.

GIGABYTE’s newest SOC Force motherboards have a number of features that help Bassiri to reach the upper limits of what a processor and chipset can achieve. “One of my favorites is OC Ignition, since it supplies peripherals with power while the system is off, no matter the PSU, and really helps keep condensation down during subzero overclocking sessions,” says Bassiri.

SOC Force motherboards also provide a range of buttons, switches, and voltage checkpoints to significantly simplify the overclocking process. “I also like the CBAT (or Clear Battery) button, which clears the time without having to remove the motherboard battery,” says Bassiri. He’s also partial to the LN2 switch that lets you go from high-speed (low-stability) to low-speed (high-stability) with the flick of a switch. “It’s great for high speed validations,” he says. Bassiri has also found the DualBIOS feature useful: “I can say I have never lost a board due to a bad BIOS flash or corruption from overclocking.”

Serious overlocks punish motherboards, and GIGABYTE uses technology to ensure top-notch power handling and reliability under the toughest loads. “I like that GIGABYTE makes a point to spell out exactly how durable their motherboards are, they tell you everything from how much copper is in the PCB to the lifespan of the capacitors,” says Bassiri. “The GIGABYTE boards that I own have never had any issues with durability, such as the PCB warping or even a blown capacitor.” For ultimate peace of mind, Bassiri suggest looking into GIGABYTE’s Black Edition motherboards, which have undergone an extra 168-hour stress test period and are backed with a five-year warranty.

“GIGABYTE also tends to use high-quality parts where you might not expect it, for instance the GA-X99-UD4 carries the same top-of-the-line power delivery components as the X99-SOC Force,” says Bassiri. So why go with an SOC Force model? “Compared

to the X99-UD4, the SOC Force should be able to overclock the memory higher because of the special SMT (or surface-mount technology) DIMM slots, but the X99-UD4 should be able to get roughly the same CPU overclock because of VRM component selection,” says Bassiri.

Robust non-overclocking-related additions is another area where Bassiri thinks that GIGABYTE shines. “With their GAMING series, I find their audio solution comparable to sub-\$100 sound cards, which is great since I don’t need to buy a sound card for decent audio,” says Bassiri. Choice and customization are another priority for Bassiri, who cites the AMP-UP Audio feature, USB ports with DACs (digital-to-analog converters), and Killer and Intel NICs as extremely useful onboard extras.

Lastly, Bassiri admires GIGABYTE’s methods of doing business. “I can say that they really want to sell a great product and they are ruled by strong morals and ethics. I have great respect for a company who is willing to compete with their products rather than their marketing.” Bassiri’s experience shows that GIGABYTE is about more than just the bottom line. ■







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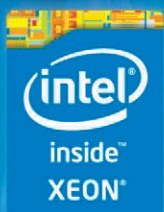


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# Read/Write Rockets

## How To Buy A Crucial SSD

The question “Should I buy a solid-state drive?” has become meaningless. Of course you should buy an SSD. With almost no exceptions, every system can benefit from some degree of solid-state storage, whether you’re building an HTPC that is up and running as fast as your TV, or a gaming rig that loads levels in a matter of seconds. An SSD belongs in your primary system, your secondary system, your parents’ computer, and their parents’ computer. Stated again, for emphasis: You should buy an SSD.

Still, there are questions, and good ones at that, you can ask as you decide what SSD to buy for your system. The number of companies warring over your system builder bucks makes the Battle of the Five Armies look like a minor squabble; you have plenty of options, so it pays to ask those questions. For example, how does the type of NAND an SSD uses affect its performance? Does it make sense to buy two SSDs and run them in a RAID 0, or are you better off simply buying one larger drive (or buying those two SSDs and not striping them)? When can you get away with a budget SSD?

The sheer number of solid-state drives on the market today can be intimidating for a newcomer, but it also means you can now buy the perfect SSD—the right mix of capacity and performance at a price that’s exactly what you want to spend. Jonathan Weech, Crucial’s SSD product marketing manager, is our man on the inside at one of the biggest SSD manufacturers in the world. He has the 4-1-1 for all of your SSD-buying FAQs.

### Numbers Game

Like every other primary PC component, much of the discussion about



Feast your eyes on Crucial’s new MX200 SSD and its wildly fast throughput: 555MBps sequential reads, 500MBps sequential writes, random 4KB reads of 100,000 IOPS, and random 4KB writes of 87,000 IOPS. Understanding what each of these numbers represents can help you make the right buying decision.

solid-state drives involves cold, hard numbers. And truthfully, that’s not unfair. No one considers an SSD’s heart when evaluating it, and an engineering team “giving it their all” to make a quality product doesn’t count for much. The proof is in the performance.

An SSD’s performance is most commonly assessed by two metrics: sequential and 4KB random performance. Each of these break down into read and write operations, so you wind up with four performance values to consider and compare.

Crucial’s new, blazing-fast MX200 SSD serves as a model for understanding each number beyond “bigger is better.”

The 250GB MX200 delivers sequential reads of 555MBps, sequential writes of 500MBps, 100,000 IOPS for random

reads, and 87,000 IOPS random writes (and, incidentally, the 500GB and 1TB MX200 drives are rated the same). For our purposes, the formula for converting IOPS to MBps is  $(\text{IOPS} * 4\text{KB per IO}) / 1,024$ . So, 100,000 IOPS becomes 390.6MBps, and 87,000 IOPS converts to 339.8MBps. With these numbers in mind, let’s put away the calculator and break out the microscope, because what looks straightforward requires closer examination.

Sequential reads and writes are your system’s “big” files—anything over 512KB qualifies. (In truth, files as small as 128KB could also be considered large based on some, but not all, SSD operations; 512KB is more all-encompassing as far as what an SSD views as a large file.) A



sequential operation will read or write a bunch of these “big” files in rapid succession, or sequentially.

Curious about those scare quotes? In an era of 6TB hard drives, BD-XL media, and massive 4K video files, 512KB is a trivial size. With this mentality, it would be easy to see an SSD’s sequential reads/writes exceeding 500MBps and think, “Everything I use my PC for will run at wicked-fast speeds!” Not so, uh, fast. Although large file operations are relatively common, they’re far from the only work your PC does. Specific system use varies from user to user, so we’d hesitate to say that sequential workloads constitute more than 50% of any desktop PC’s use. In short,

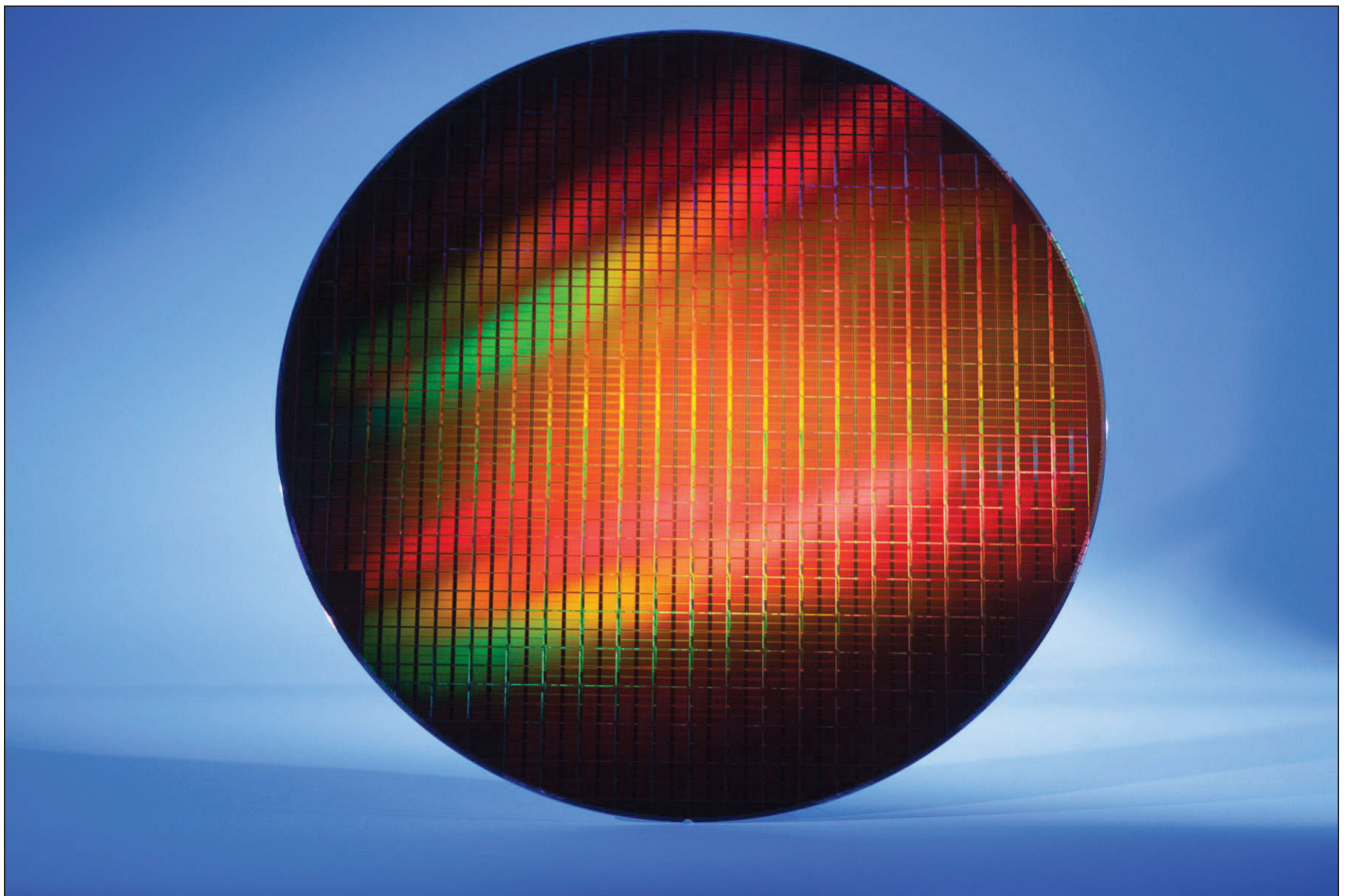
solid-state drives are fastest when they can work with big chunks of data arranged in order, but that’s not the only work they have to do.

As a slight aside, although solid-state drives easily outclass their magnetic ancestors with sequential workloads, the trusty HDD still holds its own performing its duties as a mass storage drive. Although it’s true that most HDDs won’t exceed 200MBps, this performance gap isn’t nearly as glaring as the difference in random read/write performance, where SSDs can easily be 50 times faster.

Solid-state drives’ random performance is the primary reason we buy (and love) them. Booting Windows is a great, illustrative example of a random

workload, where your PC must access lots of small files. System boots and launching applications at ridiculous speeds are the first things power users notice when switching from magnetic to solid-state storage. Indeed, it’s the reason the first affordable SSDs were colloquially known as boot drives: Not only were they so much better at booting Windows, their capacities were such that enthusiasts had room to install Windows, a frequently used game or two, and little else.

“Real-world desktop applications will rarely be 128KB sequential,” Weech says. “Most operations will be 4KB transfer sizes, with some amount of randomness to them.”



Behold, a wafer of 16nm NAND Flash memory. Crucial is at the forefront of NAND development, producing denser chips that lower solid-state drive costs. Although NAND produced on a smaller process typically performs slightly slower, manufacturers continue to offset the performance hit with innovative controller designs.

Generally speaking, random read and write performance tends to be a better way to compare one SSD with another. An SSD with superior random performance, which is usually its ability to power through 4KB read/write tests, will feel snappier than a competing SSD. Still, that's only part of the equation.

Returning to our 250GB MX200, Crucial rates the drive's performance with random 4KB reads (390.6MBps) and writes (339.8MBps) at a queue depth of 32. Queue depth is somewhat analogous to a multithreaded CPU workload. A queue depth of 32 means that an application(s) has sent 32 simultaneous requests to an SSD's controller. A controller that can capably juggle these requests results in increased random 4KB performance in the SSD.

But just as not every task a CPU faces is multithreaded, you actually have to hit the SSD with 32 data requests in order for it to produce those lofty IOPS. In the real world, a scenario like this is common in enterprise settings, but a desktop user will rarely saturate his SSD's storage controller with that many requests. Because of this, we also recommend seeking out an SSD's random performance at a queue depth of 1, a single request, as this represents a worst-case scenario.



Crucial's team of seasoned engineers is able to pair the right controller with the right NAND and then develop custom firmware to interact with both. The end result is a harmonious relationship between the controller, NAND, and firmware, which is another way of saying Crucial's SSDs' performance is second to none.

"[Crucial] runs drives in benchmarks with a full queue, because that's as fast as we can get the drive to run," Weech says. "In practice, in Windows you will rarely see the queue get much above 3 or 4. Most of the time, there are only one or two commands in the queue. What this tells us is that the SSD is

not the bottleneck to performance in a typical desktop system. The drive is handling commands at such a pace that the queue doesn't fill up at all compared to the pace we force it to run with a full queue in bench testing."

Although having a solid grasp of the four cornerstones of solid-state drive

"In practice, in Windows you will rarely see the queue get much above 3 or 4. Most of the time, there are only one or two commands in the queue. What this tells us is that the SSD is not the bottleneck to performance in a typical desktop system."

-Jonathan Weech, Crucial SSD product marketing manager



performance—sequential reads, sequential writes, random reads, and random writes—goes a long way toward understanding and evaluating an SSD, there are other factors you need to consider. Numbers don't lie, but they don't tell the whole story, either.

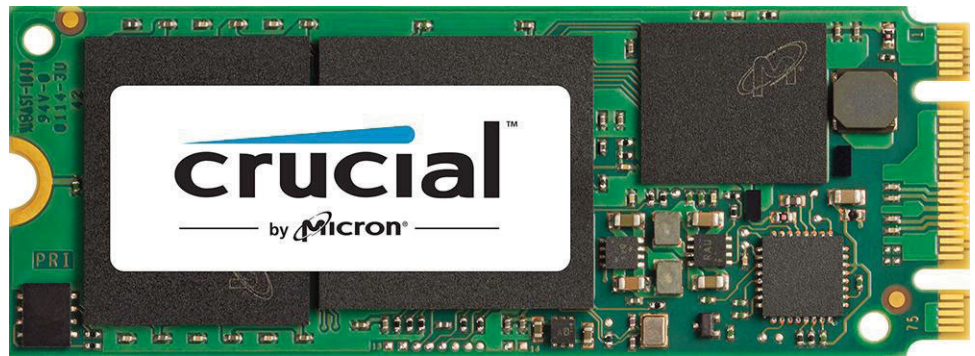
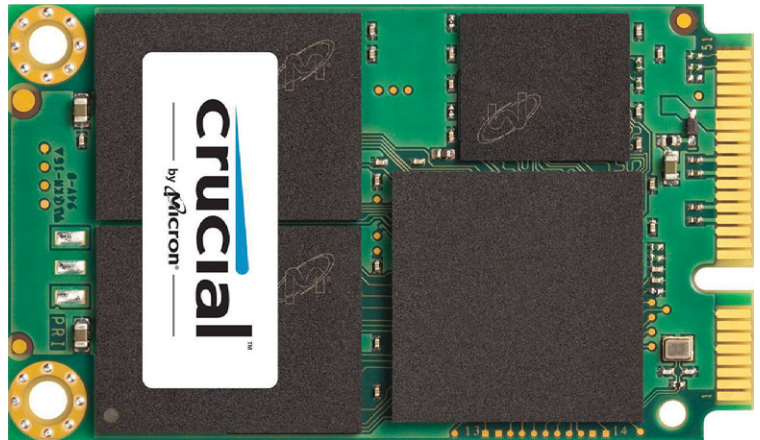
### Compression Discussion

Let's stay parked in the land of workloads a moment longer. Before you wholeheartedly accept a manufacturer's reported peak performance, be sure to read the fine print and determine whether a given SSD requires compressible data in order to achieve its rated speed.

If your first thought is, "I hardly ever work with zipped files, so my new SSD is going to be Ferrari fast no matter how I use it," think again. All sorts of file formats are already compressed. In fact, compressed files are the reason we're able to stuff our drives full of JPEGs, MP3s, and MP4s. Other files, such as RAW images and WAV files, are uncompressed. EXEs and DLLs are other examples of files that are compressible.

Knowing the difference between a compressible and incompressible workload might impress a few of your geeky friends at the next LAN party, but you can't realistically influence what type of data your SSD chews on at any given time. Benchmarks are clean, letting you test an SSD with data that's 100% compressible. The real world is messy, and every SSD must get its hands dirty with incompressible data.

Solid-state drives that boast outlandish throughput with compressible data may not sparkle as brightly when they're subjected to incompressible files. Because of this, we prefer our SSDs' storage controllers to treat compressible and incompressible data equally, like the Crucial MX200. Regardless of workload, all of the MX200 SSDs can perform at their rated speeds.



Traditionally enthusiasts have turned to 2.5-inch SSDs for the best possible performance, leaving laptop owners and mini PC builders with smaller form factor drives that can't quite keep up. Crucial's mSATA (above, top) and M.2 (above, bottom) MX200 solid-state drives are just as fast as their 2.5-inch brethren.

### Pop The Hood

To find out what really makes a solid-state drive tick, you need to pry off that sleek metal housing and get a good look at what's going on inside. (*Ed. note: Good grief! Don't actually do this. In some cases, you'll actually void your SSD's warranty. Leave it to maniacal hardware reviewers to do the job for you.*)

The two primary components inside an SSD are its NAND flash memory and the storage controller. NAND is where your data is stored, and it's undergone quite an evolution since SSDs first hit the scene. NAND is subject to the same semiconductor manufacturing process as CPUs, GPUs, and DRAM, although producing NAND with a smaller process is a double-edged sword. As the manufacturing process shrinks, the cost to produce the NAND for a solid-state drive drops, but denser NAND is slower, too.

The type of NAND used in an SSD has also changed dramatically. The earliest SSDs relied on SLC, or single-level cell, NAND, which is NAND that can hold one bit of data per cell. SLC is fast and lasts forever (where forever = 100,000 erase/write cycles, approximately), but the catch is that it's costly and not very dense, as far as capacity is concerned. In order to produce SSDs that were relatively affordable, even for early-adopting power users willing to shell out extra cash for the best hardware, companies developed MLC (multi-level cell) NAND. This was the game changer, letting manufacturers create drives that were far less expensive than those that used SLC. One cell of MLC NAND can hold two bits of data per cell, though it isn't as fast nor as durable (MLC NAND is typically rated for 3,000 to 10,000 erase/write cycles) as SLC. Despite SLC's vastly superior write endurance, most

## Solid-State Storage For Everyone

	Sequential read (MBps)	Sequential write (MBps)	Random read (IOPS)	Random write (IOPS)	Price
250GB MX200 (2.5-inch)	555	500	100,000	87,000	\$119.99
500GB MX200 (2.5-inch)	555	500	100,000	87,000	\$219.99
1TB MX200 (2.5-inch)	555	500	100,000	87,000	\$469.99
250GB MX200 (mSATA)	555	500	100,000	87,000	\$119.99
500GB MX200 (mSATA)	555	500	100,000	87,000	\$219.99
250GB MX200 (M.2, Type 2260 or 2280)	555	500	100,000	87,000	\$119.99
500GB MX200 (M.2, Type 2260 or 2280)	555	500	100,000	87,000	\$219.99
120GB BX100 (2.5-inch)	535	185	87,000	43,000	\$69.99
250GB BX100 (2.5-inch)	535	370	87,000	90,000	\$105.99
500GB BX100 (2.5-inch)	535	450	90,000	90,000	\$199.99
1TB BX100 (2.5-inch)	535	450	90,000	90,000	\$399.99

power users won't burn out an MLC-based SSD before they're ready to upgrade, so the cost savings of using MLC tips the balance in the latter's favor.

Less expensive but slower NAND might appeal to budget buyers, but at some point enthusiasts will say, "enough is enough." Allow us to introduce the solid-state drive's storage controller, also called a storage processor in some circles. It takes a fair amount of engineering wizardry to continue to fabricate NAND on smaller and smaller processes, but there's just as much as much brain power invested in making storage controllers more powerful. In fact, the considerable effort invested in making a storage controller be the best it can be is one of the reasons modern MLC-based SSDs offer better performance than the earliest SSDs, which used SLC. When you need look beyond reported throughput numbers, an SSD's controller is the primary way to distinguish it from the rest of the competition, and with so many SSDs promising similar performance, a dynamite storage controller can be a deciding factor, but not the only factor.

"SSD controllers act as the traffic cop internal to the drive itself and make sure data gets passed between the system bus and the NAND quickly, efficiently, and safely," Weech says. "Many of the features key to modern SSDs like TRIM, wear leveling, and power loss protection wouldn't be possible without the improvements we have seen in SSD controllers in recent years."

There's a final element that makes up the trinity of SSD components, the firmware. Here again, the MX200 is an excellent example. Unlike the many of SSD manufacturers, Crucial has the benefit of producing its SSDs' NAND under its own roof, so the company is able to develop custom firmware that lets its drives' controller work hand in hand with Crucial's homegrown for the best possible performance.

"We know all the nuances of our NAND," Weech says, "so we can leverage the controller with our custom firmware to do some really unique things."

The alliance of Crucial's custom firmware, its NAND, and the storage controller is what makes a lot the MX200's magic. For starters, the majority

of MX200 SSDs (the 2.5-inch 250GB MX200 and all of the mSATA and M.2 form factor MX200s) feature Crucial's proprietary Dynamic Write Acceleration technology, which treats a portion of the drive's NAND as SLC in order to bolster its performance and make the SSDs as fast as the 500GB and 1TB 2.5-inch MX200 drives.

Many of the MX200's other innovations make it more than a mere solid-state speed demon. Crucial's RAIN (Redundant Array of Independent NAND) is designed to behave similarly to a mirrored RAID configuration and provide additional data resilience. The drive's four layers of Exclusive Data Defense take reliability even further, protecting files in the event they become corrupted.

Beyond that, the MX200's custom firmware gives the SSD capabilities you'd expect to find on much more expensive enterprise drives. Each MX200 locks down data with 256-bit encryption; the SSDs meet Microsoft eDrive, IEEE-1667, and TCG Opal 2.0 encryption standards. And by using Crucial's Adaptive Thermal Protection, the MX200 drives can dynamically modify their component activity based on individual system use, which results in lower drive temperatures.

### Solid Selection

Perhaps more than any other component, the SSD market has exploded over the last few years. Although there are literally hundreds of drives to choose from, which can be confounding for newbies, you can use this to your advantage and score the perfect drive for your system. In addition to a wide range of capacities and performance tiers, solid-state drives are now available in several form factors, letting you bless nearly any system with the gift of solid-state storage.

Crucial's fleet is particularly impressive. At front and center is the already mentioned MX200, which is available as a 2.5-inch drive in capacities of 250GB, 500GB, and 1TB. At the time of this writing, you could buy these drives directly from Crucial for \$119.99, \$219.99, or \$469.99, respectively. The 500GB and 1TB MX200 drives match the rated performance of the 250GB MX200.



During the early generations of solid-state drives, 250GB was a simply mind-boggling capacity. But as PC hardware continues its march of progress, software matches it stride for stride with ever-increasing demands. Games, for example, have ballooned in size to the point where 50GB of storage space is not an unreasonable request for a game. Thanks to games' and other large applications' insatiable appetite for an SSD's NAND, a 250GB SSD is a good starting point if you want to have a handful of games and/or important programs locally installed. For larger carousels of games, or if you crave solid-state performance for every single app you use, then a 500GB drive makes a lot of sense.

If you have the bankroll for a 1TB MX200, then you should have room to store a portion of your media collection. Although SSDs can't truly compete with HDDs as mass storage drive, we have reached a point where a hard drive is no longer necessary to build a system. That's encouraging.

Crucial also extends the MX200 family to a pair of smaller form factors, mSATA and M.2. You won't be able to get a 1TB MX200 in either of these form factors, although 250GB and 500GB models exist. The best thing about Crucial's mSATA and M.2 MX200 SSDs is that they sacrifice none of the performance of the 2.5-inch units. From a storage standpoint, the mSATA and M.2 MX200s can make your laptop or mini PC every bit as fast as a desktop that uses a 2.5-inch drive. Small form factor builders may prefer one of these SSDs, too, since physical space is a premium as case size shrinks.

"With such a broad assortment of capacities and form factors, the MX200 can meet the needs of nearly everyone from a hardcore gamer with a fully modded, custom-built system to the ultrabook-toting executive," Weech says.

Builders who need to allocate more of their budget to other components, or who don't need a drive as large as 250GB, can turn to Crucial's BX100 series. This quartet of drives makes solid-state storage even more affordable. Buying direct from Crucial, the 120GB, 250GB, 500GB,

and 1TB BX100s cost \$69.99, \$105.99, \$199.99, and \$399.99, respectively. Thanks to value-priced drives like the BX100 family, there really isn't a good reason not to install an SSD in every system.

"The BX100 is focused on delivering a tremendous amount of bang for the buck," Weech says. "It's no slouch in performance and is ideal for someone looking for a great SSD value."

### The Next Generation

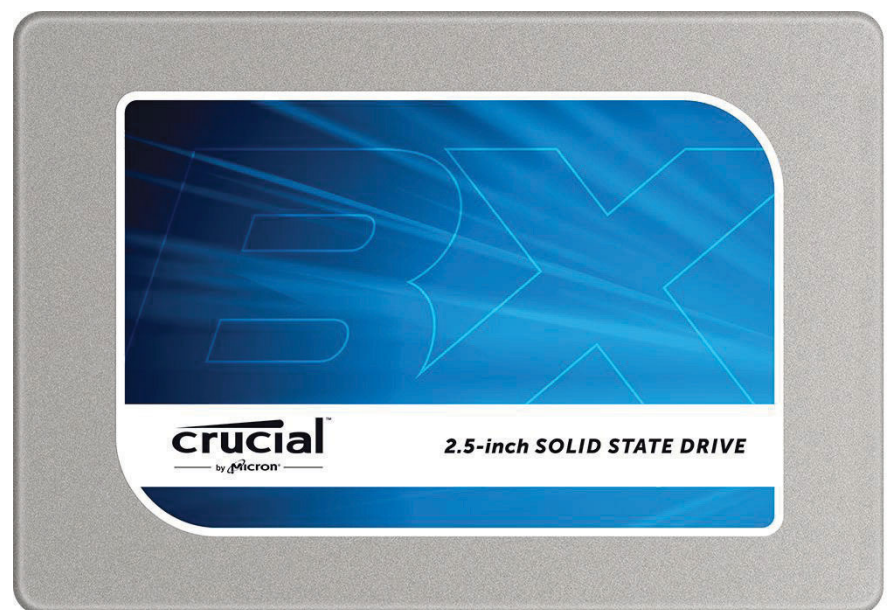
The fastest SATA protocol, regularly called "SATA III" to the chagrin of SATA-IO (the organization that develops and maintains the SATA protocol), has been an official standard for nearly six years. The 6Gbps SATA interface's maximum theoretical bandwidth converts to 750MBps, which gives the appearance that SATA SSDs still have plenty of room to grow. But after factoring overhead, such as 8b/10b encoding, the real-world bandwidth limit is 600MBps; solid-state drives have been capable of producing sequential reads and writes exceeding 500MBps for a while, so 6Gbps SATA, like its 3Gbps predecessor, will become

a bottleneck as manufacturers develop faster controllers and NAND. This is a big reason why the SATA Express and M.2 interfaces are nipping at the heels of 6Gbps SATA.

M.2 drives are already available, although they tend to continue to use the 6Gbps SATA bus instead of the faster PCI Express bus. Currently, there are no native SATA Express drives. However, this hasn't stopped the industry from preparing for their arrival. Motherboard manufacturers have been releasing board after board with M.2 and/or SATA Express ports, so it's only a matter of time before we start seeing an influx of drives that take advantage of these next-gen interfaces.

### Drive Time

Solid-state drives continue to grow in capacity. They're getting faster, too. And perhaps best of all (when you're faced with upgrading several components or building a new system from scratch), the cost per gigabyte continues to plummet. For power users looking for a new SSD, it's a win-win-win situation. Find the drive you want, and start winning. ■



Crucial recognizes that not every buyer needs the ridiculous speed of the MX200 drives; sometimes, merely having a faster option than a hard drive is enough. Case in point: the BX100 family, which lets builders buy lots of fast, solid-state storage without breaking the bank.

# DCCASEMODS' Custom Painted Corsair 250D

## Win This Mod

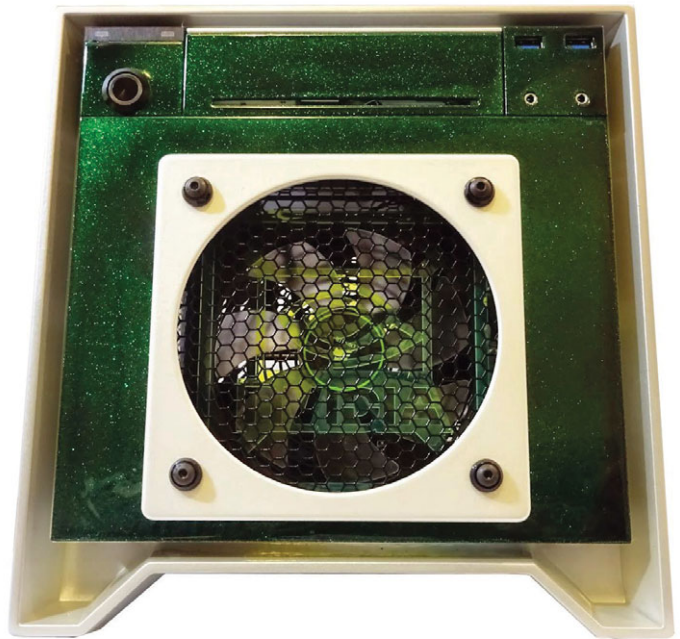
Modders are a rare breed, and although *CPU* is deeply invested in spreading the word on this rewarding hobby, the fact remains that most of us have neither the time nor the tools to create visually arresting mods like the ones that grace the cover of the magazine. Rarer still are professional modders who offer mod-for-hire services to the average consumer. For David “Bishopdown” Wright, head modder and CEO of DCCASEMODS ([www.dccasemodding.com](http://www.dccasemodding.com)), building affordable—yet beautiful—systems is a founding principle of the business.

In 2005, Wright was looking for a system that was powerful enough to meet his needs, but affordable enough to meet his budget. Out of frustration with the dearth of viable options on the market, Wright built his own system and never looked back. Four years later, the business was born.

Atlanta-based DCCASEMODS makes one-of-a-kind computers, coats cases with automotive-grade paint in a variety of striking colors, installs custom liquid-cooling systems, performs PC and Mac diagnostics and repairs, and more. But for PAX East attendees, the

company is looking to introduce itself and leave a lasting impression.

DCCASEMODS and *CPU* are partnering to give attendees a chance at winning a unique Corsair Obsidian Series 250D Mini-ITX enclosure. For the case, Wright chose a two-tone paint scheme that consists of a Snow White Pearl frame and grilles paired with metallic flake Organic Green Kandy panels, with several layers of clear coat on top to give it a more durable finish. The inside features a high-gloss black



finish. According to Wright, “I really love this case. It’s small but roomy, has good air flow, and it’s screaming to be modded.”

Features include an illuminated Delrin power switch from Lamproton, aftermarket Lian Li thumbscrews, and DCCASEMODS radiator grille templates used as fan grilles backed with modder’s mesh. MNPCTECH supplied the NVIDIA-themed acrylic fan grilles that you see in the front panel. The case also comes with an 850W Corsair CS850M PSU, four green LED-lit 120mm fans in the side panels and another 140mm green LED fan in the front panel. The lucky winner at PAX East will have a big head start on a new and attractive system. Just because modding isn’t your thing doesn’t mean you have to be stuck with stock. ■

### Not Attending PAX But Want To Win?

In addition to the *CPU* raffle occurring at PAX East, DCCASEMODS has put together another attractive work of art based on the Corsair Graphite Series 230T. This striking scarlet midtower, dubbed Red Wonder, is also up for grabs. To learn more about your chance at winning it, visit [www.dccasemodding.com](http://www.dccasemodding.com).





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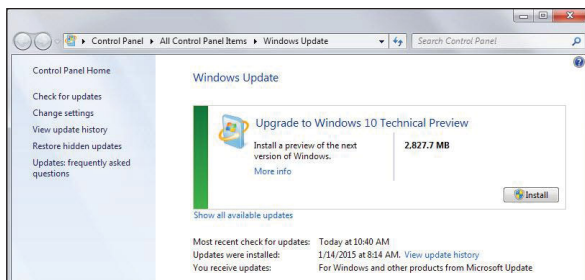


## Windows 10 For Enthusiasts

Enthusiasts and operating systems have a love-hate relationship. For many of us, the OS is the necessary evil that allows us to game, create content, and tap into the full potential of our overclocked components. At their worst, OSes consume too much memory, take ages to boot, hide common tasks behind half a dozen submenus, and insert too many layers of software between the user interface and the hardware. If an OS is bad for the people who use computers most (that's you and me), then it's bad for kids, moms, retirees, businesses, and everyone else who uses a computer to one degree or another. With Windows 10, however, Microsoft appears to be listening to what enthusiasts are saying. Here we'll break down just how enthusiast-ready Windows 10 might be when it launches later this year.

### Free As In Beer

It's true, enthusiasts who see the value in spending a little extra on their hardware aren't so anxious to pony up for an operating system license the moment a new one hits the street. Even a modest boost in performance usually isn't enough to coax mass adoption among enthusiasts. According to the latest Steam Survey, 57.4% of gamers are still running Windows 7 (32/64-bit) and just 32% have made the



In a move frequent PC builders will surely applaud, Microsoft is moving to enable OS upgrades via Windows Update.



Want to get an early look at Windows 10? Download and install the Windows 10 Technical Preview.

leap to Windows 8/8.1 (32/64-bit). With Windows 10 coming in hot, we wouldn't expect those Win8 numbers to get much higher than they are.

The simple fact is, people who love computers don't necessarily love new operating systems. The cost of a license has always been a major hurdle to adoption, but for users who maintain multiple systems in a single household, the cost of upgrading can balloon quickly. But with Windows 10, Microsoft has made upgrading more affordable than ever.

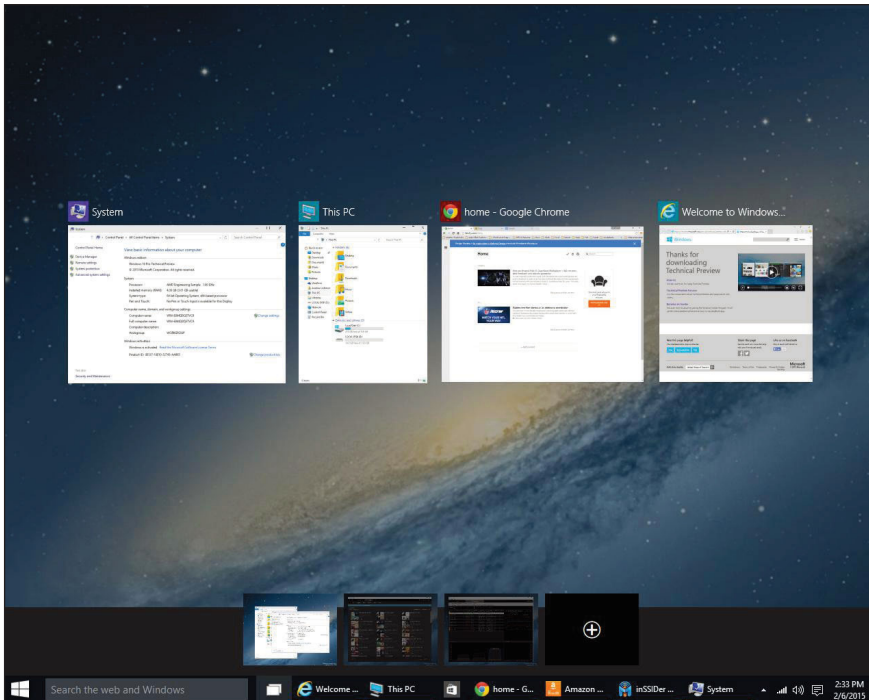
Microsoft recently announced that during the first 12 months that Windows 10 is available, it will be a free upgrade

for anyone running Windows 7, Windows 8, or Windows 8.1. Windows Enterprise customers are excluded from the free offer, but most users are probably running a consumer version of Windows. If you have a Windows XP or Windows Vista system or two, you'll need to pay for a full license, the price of which has not been disclosed as we went to press. If you find yourself weighing the cost of a license against the benefits of upgrading whenever a new OS comes out, Windows 10's introductory offer makes that debate moot.

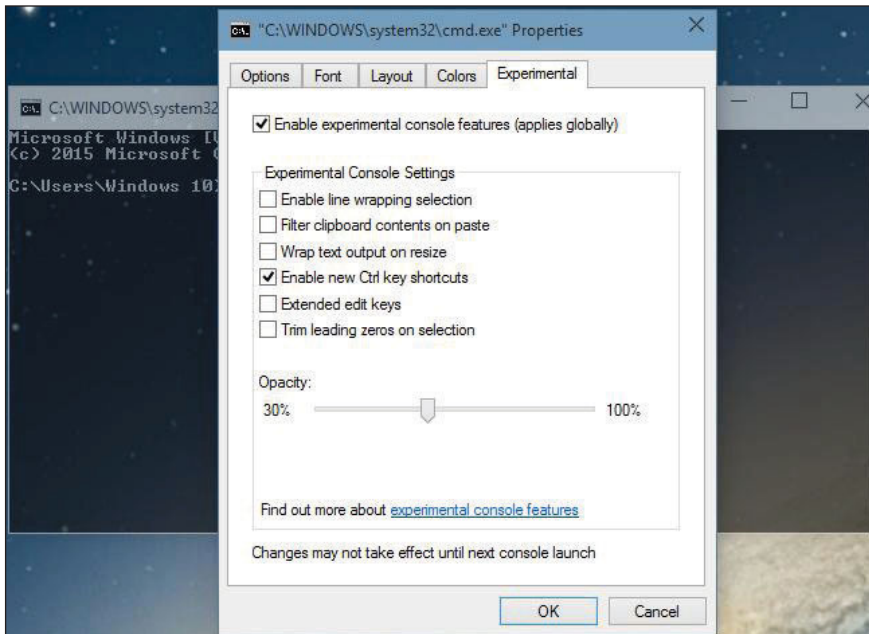
### Upgrade With Ease

When you've spent countless hours building your system, configuring the software, and tweaking performance, the last thing you want to do is start over again without a good reason. Since Windows XP, Microsoft has made





Virtual desktops is a welcomed new addition for Windows power users.



If you spend a lot of time using the console, check out the experimental features that will ship with Windows 10.

great strides in streamlining the time-consuming and sometimes complicated process of installing a new operating system. But what if Microsoft used the

mechanism already in place to deliver smaller updates and fixes to its software for an OS upgrade? That's right, when it launches, users will be able to upgrade

their Win7, 8, or 8.1 PCs to Windows 10 using Windows Update.

The Windows 10 Technical Preview build 9926 was our first taste of this capability. To access this option, users can go the Windows 10 Technical Preview page ([bit.ly/1yzrtwc](http://bit.ly/1yzrtwc)), click the Start Upgrade Now button, and download a small executable, aptly named "Windows10TechnicalPreview.EXE." Install the utility and upon a restart, the Technical Preview Upgrade download will be delivered via Windows Update. No more burning ISOs to bootable thumb drives, DVD-Rs, or using ISO mounting software.

It seems like a small improvement, especially to those who tend to buy systems with the OS already installed. But it's a big deal for the type of person who installs upgrades on a fairly regular basis. Enthusiasts are definitely that type of person.

Another promising development is the fact that when Windows 10 releases, those running the Technical Preview will be able to upgrade (not necessarily for free) to the retail version without losing a shred of data. That's good news for the million-plus early adopters who have installed the Technical Preview as we went to press.

## Windows 10 Virtual Desktops

Linux and Mac OS X users have known the joy of virtual desktops for quite a while, but Microsoft is finally bringing the multitasking-friendly feature to Windows. In short, virtual desktops let a user maintain a web browser and a series of applications open, then swap "desktops" to open a new series of applications and web pages. It's a good way to keep the projects you're working on easily accessible, but separate.

Task switching is an operation Win7, 8, and 8.1 users are all readily familiar with. Just press ALT + Tab and thumbnails of the open applications will appear in the center of the screen, so you can easily click the one you want to maximize. It's an intuitive command and it gets a lot of use by those who tend to juggle many tasks at once, but are short on screen space.

In Windows 10, this function will do the same thing, but clicking the new Task View

button on the taskbar (or pressing Windows Key-TAB) displays open applications and lets you launch a new virtual desktop by clicking the black square with the plus symbol (+) in it. Now you can launch new applications here without getting them lost among those open on the primary desktop. Perform the function again and you can see all currently running virtual desktops along the bottom of the screen. Just click one to access it. Gone is the Aero Flip 3D function, but virtual desktops seem a worthy replacement.

## The Console

The console, typically accessed via the Windows Command Prompt, is the power user's screwdriver. This utility is extremely powerful, enabling users to bypass the UI and type in MS-DOS commands to perform a wide variety of functions, from formatting storage devices to performing batch file scripting. When running Command Prompt, applications you input commands for are said to be operating in character mode. If you need a refresher, you can always type **help** and press ENTER to see a list of available commands.

We'll get to the cosmetic and functional changes in a bit, but Microsoft also made some notable tweaks to the architecture of the console. The console as we know it is actually run within conhost.exe, also called the console host. It registers keyboard and mouse input, draws text to the screen, sets aside memory buffers, and launches

```

C:\Users\Windows 10>help
For more information on a specific command, type HELP command-name
ASSOC      Displays or modifies file extension associations.
ATTRIB     Displays or changes file attributes.
BREAK      Sets or clears extended CTRL+C checking.
BCDEDIT    Sets properties in boot database to control boot loading.
CACLS      Displays or modifies access control lists (ACLs) of files.
CALL       Calls one batch program from another.
CD         Displays the name of or changes the current directory.
CHCP       Displays or sets the active code page number.
CHDIR      Displays the name of or changes the current directory.
CHKDSK     Checks a disk and displays a status report.
CHKNTFS    Displays or modifies the checking of disk at boot time.
CLS        Clears the screen.
CMD        Starts a new instance of the Windows command interpreter.
COLOR      Sets the default console foreground and background colors.
COMP       Compares the contents of two files or sets of files.
COMPACT    Displays or alters the compression of files on NTFS partitions.
CONVERT    Converts FAT volumes to NTFS. You cannot convert the
           current drive.
COPY       Copies one or more files to another location.
DATE       Displays or sets the date.
DEL        Deletes one or more files.
DIR        Displays a list of files and subdirectories in a directory.
DISKPART   Displays or configures Disk Partition properties.
DOSKEY     Edits command lines, recalls Windows commands, and
           creates macros.
DRIVERQUERY Displays current device driver status and properties.
ECHO       Displays messages, or turns command echoing on or off.
ENDLOCAL   Ends localization of environment changes in a batch file.
ERASE      Deletes one or more files.
EXIT       Quits the CMD.EXE program (command interpreter).
FC         Compares two files or sets of files, and displays the
           differences between them.
FIND       Searches for a text string in a file or files.
FINDSTR    Searches for strings in files.
FOR        Runs a specified command for each file in a set of files.
FORMAT     Formats a disk for use with Windows.
FSUTIL     Displays or configures the file system properties.
FTYPE      Displays or modifies file types used in file extension
           associations.
GOTO       Directs the Windows command interpreter to a labeled line in
           a batch program.
GPRESULT   Displays Group Policy information for machine or user.
GRAFTABL   Enables Windows to display an extended character set in
           graphics mode.
HELP       Provides Help information for Windows commands.
ICACLS     Display, modify, backup, or restore ACLs for files and
           directories.
IF         Performs conditional processing in batch programs.
LABEL      Creates, changes, or deletes the volume label of a disk.
MD         Creates a directory.
MKDIR      Creates a directory.
  
```

Want to expand the Control Prompt window? Just click and drag.



It may take a while before we can truly enjoy the benefits of DirectX 12, but getting Windows 10 is the first step in the process.

APIs. In Windows Vista, every function of the console went through conhost.exe. In Win10, this is set to change.

Now, when you launch conhost.exe, it can determine whether the application supports the new features. If not, then the console launches in a kind of legacy mode, as would be the case when running a 16-bit NTVDM (Windows NT Virtual DOS Machine) application on an x86 system. If the application supports it, conhost.exe launches with support for all the new features.

Win10's new and improved command prompt supports a handful of new settings that let you change how the utility looks and performs. To access the new settings, launch the new Command Prompt window by pressing Windows Key-R (this launches the Run utility), then type **cmd** and press ENTER. Click the thumbnail in the upper-left corner of the Command Prompt window and click Properties. The Command Prompt Properties menu looks similar to that on Win8 and earlier, save for the Experimental tab. Click the checkbox at the top of the window to enable the new features and the start checking boxes to see how they change the Command Prompt window.

One of our favorite new changes is the support for a window that is wider than 800 pixels. Like any other window, you can adjust the size of the Win10 Command Prompt window by clicking and dragging



at the edge. As you change the size of the window, the buffer will shrink and grow automatically to accommodate the change.

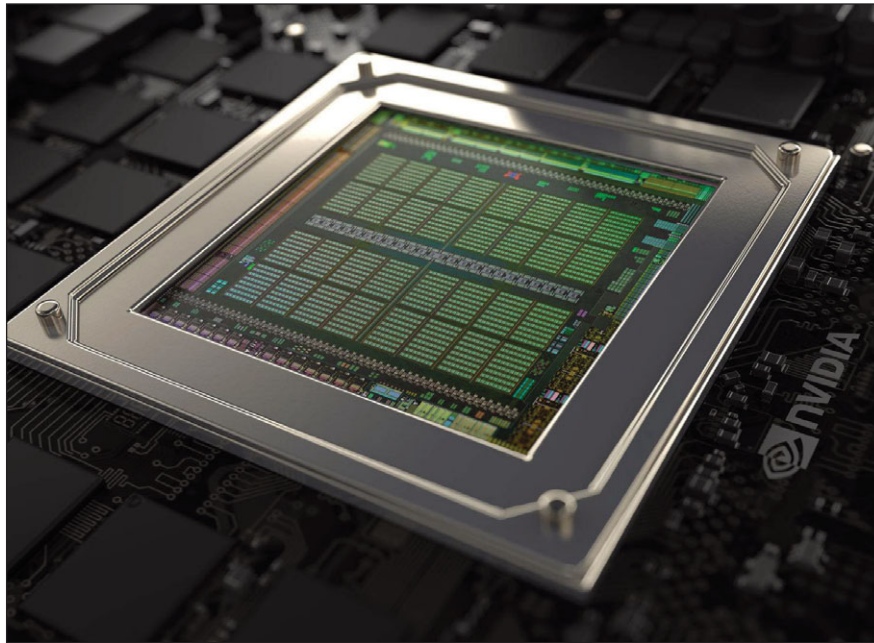
Word wrap, not possible in previous versions on the Windows console, is now available thanks to conhost.exe's new code base. It lets the application retain context and line breaks, even when data moves between text applications and the window size changes.

Enable Quick Edit Mode from the Options tab on the Command Prompt Properties menu and you'll be able to use your mouse select text line-by-line, similar to how you select text in web browsers and word processing applications. Text selection can also be performed using the SHIFT, HOME, END, CTRL, PAGE UP, PAGE DOWN, and ARROW keys.

You can also adjust the opacity of the Command Prompt window, you know, because see-through stuff is cool.

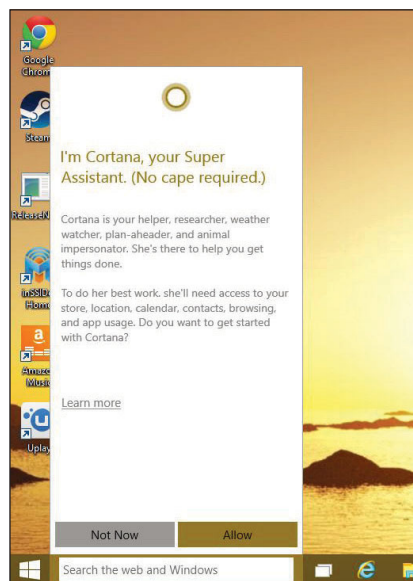
## DirectX 12

We've been hearing about DirectX 12 for quite a while now, but Microsoft has confirmed that the next version of the firm's graphics-centric API will be making its debut in the retail version of Win10. DX12, like AMD's Mantle API, is designed to reduce driver overhead as much as possible. This comes in the form of improved multithreaded scaling and decreased CPU utilization. Microsoft claims to be able to do this through a handful of new features, including descriptor tables, concise pipeline state objects, and draw call bundles, all of which enable the OS to better match the graphics hardware with the Direct3D abstraction layer.



NVIDIA's Maxwell GPUs (as well as Kepler and Fermi) are ready to support DirectX 12's new capabilities.

The list of hardware-dependent features going into DX12 hasn't been finalized, but they do offer a hint at Microsoft's ambition with regard to the specification. Some of the features currently under consideration include volume tiled resources



Cortana is like Windows Search on steroids.

and conservative rasterization, which both are prerequisites for VXGI, or voxel global illumination, a realistic lighting technique. This feature is also planned to be a part of DX11.3, which hopes to back port some of DX12's features for Win7 and 8/8.1 users who don't upgrade to Win10.

Another goodie that'll probably be baked into DX12 is called raster ordered views, which is designed to enable real-time order-independent

transparency without crippling the rendering hardware. This feature could be used to render more lifelike blended textures and complex transparent objects such as smoke, fire, and water. Command lists and bundles are designed to keep the workload balanced between the CPU and GPU, new concise pipeline state objects simplify how the state-changing process occurs and unifies the pipelines to slash overhead and let the graphics hardware perform more calls per frame. In DX12, game developers can use descriptor heaps and tables to store frequently-used resources to save the GPU from having to redraw them each time. Other buzzwords you may see on DX12's list of ingredients include swizzled resources, compressed resources, new blend modes, programmable blend, and typed UAV load.

Although previous iterations of the API have offered incremental improvements—often only visible when running higher-end graphics hardware—DX12 promises to be significantly more power efficient, giving more affordable gaming hardware a chance to shine.

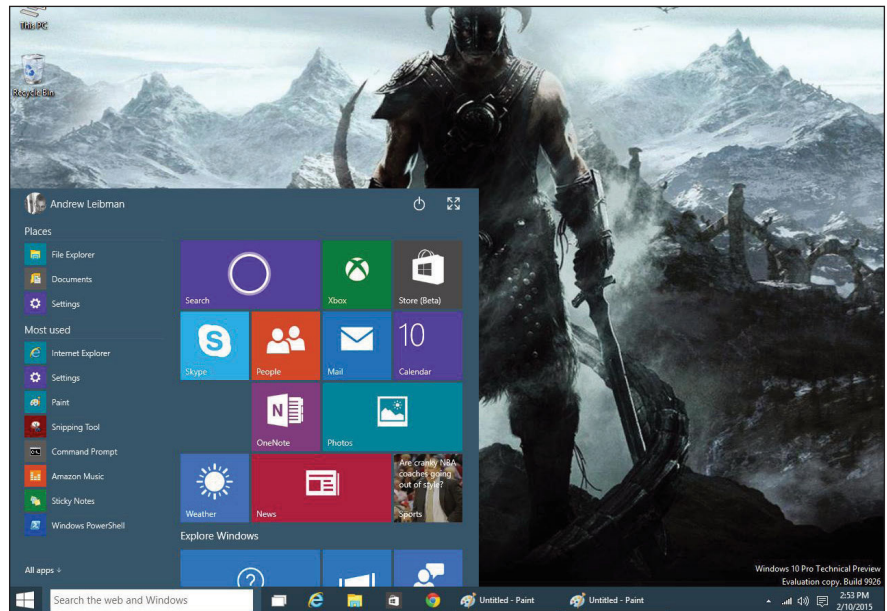
As we went to press, Intel, NVIDIA, and AMD reported that their current stable of Haswell and later, Fermi and later, and GCN-based graphics cards, respectively, will support DX12 in some form. That last part is key. It's not yet clear if the GPUs (and CPUs) that are slated to support DX12 will be able to handle every aspect of the new API, or just the core specification, with support for a few hardware-dependent features restricted to new hardware capable of tapping into the full specification.

Microsoft's Xbox One is also reported to be getting a software upgrade to DX12, but if DX12 support ends up being split between legacy hardware and post specification hardware, then the Xbox One will be in the former category. That being said, the Xbox One already supports at least one DX12 feature via a customized version of the DX11 API; draw bundles. Because much of DX12's performance improvements are dependent on this feature, and a generous pool of pixel shaders, DX12's advent on the console is likely to be less monumental than for PC.

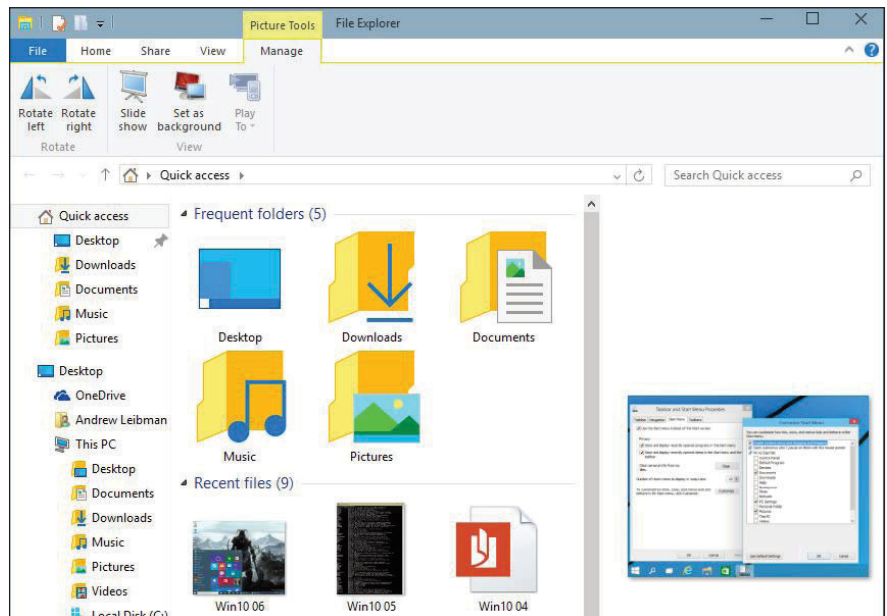
Until we have Win10 in-house, GPUs that supports its full suite of features, and games that are built using DX12, we won't be able to fully explore just how much more efficient the new API will be compared to DX11. Despite this, an Intel-designed DX12 asteroid field demo from SIGGRAPH 2014 showed a 50% to 70% rendering speed and CPU power consumption improvement compared to DX11. Although it's far from a real-world scenario, the numbers are impressive.

## Xbox Streaming

The head of Microsoft's Xbox division, Phil Spencer, recently announced that gamers will be able to stream games from the Xbox One to a PC or tablet running Windows 10. The game streaming technology is restricted to wired or Wi-Fi connections, so you won't be playing The Master Chief Collection in on a domestic flight anytime soon, but the prospect of being able to access our games in more places is always a good thing.



The Windows 10 Start button is a lot like it used to be on Windows 7, with a splash of Windows 8 in the form of live tile support.



The Windows File Explorer has seen a number of improvements in Windows 10.

## Windows Turned Up To 11

As you can see, there are a good number of enthusiast-friendly features under Win10's hood, but this list is by no means exhaustive. We failed to mention the illustrious return of the Start button, the intriguing concept of Cortana as a personal assistant, the streamlined Spartan web browser, deeper system-wide

OneDrive integration, the Quick Access page in File Explorer to help you access frequently used files, new touch capabilities, and more. When Win10 comes out later this year (RTM [release to manufacturing] is slated for June), it'll have a handful of features for everyone, but more than a few should be appealing to power users. ■



# Upgrades That'll Keep You Humming Along

Fix Adobe Flash Player vulnerabilities, broaden device support with HWiNFO64 and GPU-Z, and enjoy a new interface for LibreOffice in this month's software updates. NVIDIA and Intel's new drivers add support for the latest GPUs and processors.

## SOFTWARE UPDATES

### Adobe Flash Player 16.0.0.305

The 16.0.0.305 update blocks a critical, zero-day vulnerability (CVE-2015-0313) for Internet Explorer, Firefox, and Chrome—potentially allowing an attacker to take control of your PC. Adobe indicates that the vulnerability has been exploited by hackers using drive-by download attacks, so you'll want to make certain Flash Player has been updated to the latest version.

[www.adobe.com](http://www.adobe.com)

### Corsair Link 2.7.5361

Version 2.7.5361 includes a firmware update for the Commander Mini control unit and fixes a problem where the thermistor values were not showing up. Corsair also addresses an icon positioning issue. When the main tab window was resized, previous versions of Corsair Link might locate the icons outside the window. For better compatibility, Link 2.7.5361 uses a digitally signed .EXE.

[www.corsair.com](http://www.corsair.com)

### HWiNFO64 4.5

The 4.5 update for HWiNFO adds several new reporting options for NVIDIA's graphics cards. The utility can now report GPU memory, normalized power, and video engine clock. NVIDIA's GeForce GTX 960 and GM206 core also find support in HWiNFO 4.5. The update boasts improved support for Corsair Link devices, too. For better functionality, update 4.5 lets you back up application and user-specific settings for HWiNFO64. Finally, HWiNFO uses the 4.5 update to improve the rendering of tray icons.

[www.hwinfo.com](http://www.hwinfo.com)

### TechPowerUp GPU-Z v0.8.1

GPU-Z is one of the best utilities for providing detailed information about your graphics card. With update 0.8.1, TechPowerUp added support for NVIDIA's GeForce GTX 960, GTX 660 (with 960 shaders) GT 705, and GT 720. You'll also find better support for NVIDIA's mobile GPUs with additions for the GTX 980M, GTX 970M, and GT 745M. On the AMD side, update 0.8.1 adds support for the R9 255, FirePro W7100, and HD 8370D. Preliminary support is available for Intel's Broadwell on-processor graphics, too.

[www.techpowerup.com](http://www.techpowerup.com)

### The Document Foundation LibreOffice 4.4

In the 4.4 update, the Document Foundation has refreshed the LibreOffice interface to improve the usefulness of menu bars, context menus, toolbars, status bars, and rulers. For example, the Standard and Formatting toolbars are reorganized for use with an application's most frequently used features, reducing the need to search through menus or customize the toolbar. Besides the interface upgrade, LibreOffice 4.4 also adds support for OpenGL transitions in Windows. To reduce font-related issues when opening OOOXML files, LibreOffice 4.4 uses the free Carlito and Caladea fonts.

[www.libreoffice.org](http://www.libreoffice.org)

### TVersity Media Server 3.6

TVersity Media Server is a DLNA and UPnP A/V media utility, and the 3.6 update is designed to address a YouTube mandate for the use of HTTPS. With TVersity Media Server 3.6, Pro users can now once again

add YouTube URLs to the TVersity Media Server library. You'll also find support for Sony Blu-ray players to ensure the devices will be correctly detected and supported on your network. Subtitle display improvements are also part of the 3.6 update.

[tversity.com](http://tversity.com)

## DRIVER BAY

### Intel 15.36.14.4080

The 15.36.14.4080 release adds video acceleration for the VP9 and HEVC video formats. VP9 is a video format used on Google Chrome and Google Hangouts, while the HEVC format is designed for use with 4K Ultra HD video playback. This new driver is also the first to support Intel's 5th Generation processors. It'll work with the following 5th Generation on-processor graphics: Intel HD Graphics 5500, Intel HD Graphics 6000, and Intel Iris Graphics 6100. 4th Generation Intel Core processor owners can also install the 15.36.14.4080 driver.

[www.intel.com](http://www.intel.com)

### NVIDIA GeForce 347.52 WHQL

NVIDIA recently released a couple of high-profile drivers. Driver 347.25 introduced support for NVIDIA's GeForce GTX 960 and expanded MFAA (Multi-Frame Anti-Aliasing) support to nearly all DirectX 10 and 11 titles. Version 347.52 is a GeForce Game Ready driver optimized for use with Evolve by adding SLI support and compatibility with the one-click game setting tool in GeForce Experience. Driver 347.52 also delivers several performance improvements for the GeForce GTX 980 and 970.

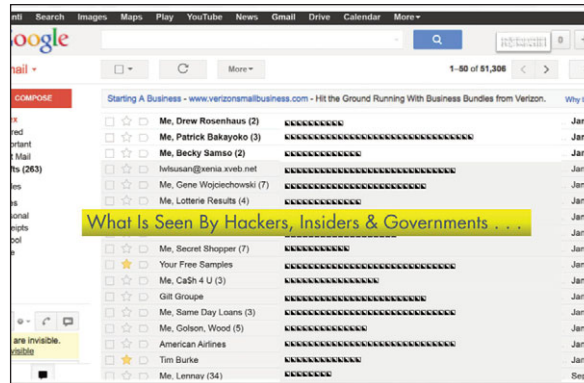
[www.geforce.com/drivers](http://www.geforce.com/drivers)

## Inside The World Of Betas

### CLOUDBASK SECURE GMAIL BETA

Securing email is harder than ever. Hackers have become better at breaking into accounts, and third-party data breaches can expose your usernames and passwords to cybercriminals. CloudMask is a service designed to protect the data in your online accounts, including webmail, online file storage, and cloud applications. Secure Gmail Beta is a web browser extension that encrypts your Gmail messages and attachments at all stages—from the email draft to when the recipient opens the message.

CloudMask uses end-to-end encryption and tokenization to secure your Gmail, so there's no need for separate hardware, security gateways, or even changes to your web applications. And even if a hacker were to break into your Gmail account, any email and attachments encrypted with Secure Gmail would be unreadable (unless the hacker logged on from the device where your digital key is stored).



#### CloudMask Secure Gmail Beta

**Publisher and URL:** CloudMask; cloudmask.com

**ETA:** March 31, 2015

**Why You Should Care:** The service offers an easy way to encrypt Gmail messages and attachments.

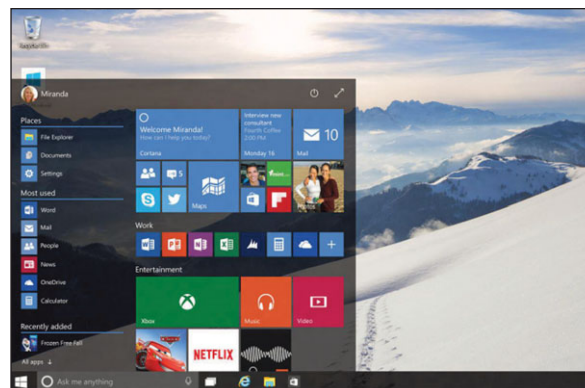
At the time of this writing, CloudMask's Secure Gmail was available as a Firefox add-on, while support for Internet Explorer and Google Chrome is expected in the first quarter of 2015. CloudMask also plans on supporting Outlook.com, Box, Google Drive, and Salesforce, among others. There's no need to configure the encryption or manually

adjust settings; it all happens in the background. However, CloudMask's total encryption does require that both the sender and the recipient sign up for the service. Fortunately, the Starter plan is expected to be free and supports today's most popular webmail clients. The service is ideal for people that use Gmail for business and other data-sensitive tasks. ■

### WINDOWS 10 TECHNICAL PREVIEW BUILD 9926

Build 9926 is the latest Technical Preview of Windows 10, and it comes with a ton of great new features that should interest early adopters. Topping of the list is Cortana for the desktop. You can access the personal assistant by clicking the onscreen microphone icon. Once Cortana is listening, you can speak reminders or a search query. Build 9926 also features Cortana's Notebook, which can provide notifications for daily tasks (from your Outlook calendar and other connected sources), important updates (such as tracking information for flights or packages), and news alerts. You can customize the alerts within the settings of Cortana's Notebook.

With Windows 10, the Start menu is back in the fold, and Microsoft has added Live Tiles to the right side of the traditional Start menu. In Technical Preview Build 9926, there's a Maximize



#### Windows 10 Technical Preview Build 9926

**Publisher and URL:** Microsoft; windows.microsoft.com

**ETA:** 2015

**Why You Should Care:** Windows 10 is taking shape, and this preview build comes with a bunch of intriguing additions.

button in the upper right corner to bring the Start menu full-screen for better access to the Live Tiles. Build 9926 also introduces Continuum Mode that automatically adjusts the behavior of the Start menu and apps based on what type of device you're using. People with tablet/laptop hybrid devices can toggle between Continuum's desktop and tablet

modes. Microsoft has also improved the Settings app to provide one place to manage display, network, and account settings. The latest Technical Preview also gives you a taste of the revamped Windows Store. (Microsoft recommends purchasing for-pay apps through the Windows 8.1 Store, which is displayed in green.) ■



# Gadgets Get Smart

## Wearable Tech Begins To Show Promise

The initial wave of wearable tech has been a big hit for fitness enthusiasts, thanks to the wide variety of health and activity tracking devices. But there's more to wearable devices than heart rate monitors, pedometers, and fitness trackers. We're starting to see augmented reality devices, smart textiles, IoT and connected home tools, wearable payment tech, and other products that offer broader appeal. These devices are helping people get things done easily and efficiently, but will everyone eventually wear their tech?

### Wearable Device Growth

Certainly, there's strong consumer interest in wearable devices. A recent study from Stratos found that 75% of respondents who didn't already own a wearable device were planning to buy

one. The same study indicated that 30% of U.S. smartphone owners already have a wearable device. Of those who owned one, 53% had a smart wristband, 32% used a wearable camera, and 24% owned a smartwatch. Smart shoes and other smart clothing were the least desirable types of wearables, as only 6% of those surveyed said they were interested in smart shoes and 5% in smart clothing.

By far, wrist wearables have been the most popular. By 2018, Parks Associates predicts smartwatch sales will reach 121 million units sold worldwide—up from 18 million units sold worldwide in 2014. Similar to a smartphone or smart TV, a smartwatch connects a user to the Internet for access to real-time data. Generally, smartwatches offer features common on smartphones, such as weather, music playback, and access to email and texts.

Several models also feature activity tracking capabilities. Depending on the model, some people can use their smartwatches to control their smart TVs, capture pictures, video chat, and run scaled-down versions of common smartphone apps.

Connected digital trackers are another wearable expected to grow. These include more basic fitness tracking and wearable GPS devices, often lacking the app-enabled customization found on smartwatches. Parks Associates estimates that connected digital trackers accounted for 52% of all digital fitness sales in 2014 and anticipates 81% of all sales by 2018.

“When discussing volume, activity trackers will continue to be the most substantial wearable device segment in 2015,” says Ben Lemieux, telecoms market analyst at Visiongain. “They are relatively inexpensive, have value to most consumers,



The Pebble Steel is a smartwatch with a strong app platform.



Just because some people are buying wearable devices doesn't mean that everyone has found the functions to be useful. "A small number of consumers are taking the plunge into wearables, and survey results indicate that up to a third of those no longer use their device six months after purchase," says Lemieux.

Some of the initial wearable offerings don't offer much value to consumers. "Notifications on a watch are not much more convenient than a smartphone in your pocket," Spencer explains. "In fact, the screen size and interface restrictions of a smartwatch make it less convenient." The large screen and mature interface on your smartphone, on the other hand, are easy to control.

Generally, the form factor of wearable devices creates certain interface challenges. "OEMs and designers are having to work with smaller screens, less battery, and processing power," says Lemieux. "They are faced with squeezing high-quality voice and audio, a pleasing visual overlay, useful and intuitive apps, and a lean operating system into a very small package."

High cost can also be a barrier to convincing consumers to buy into wearable devices. "The big players have observed the success and popularity of low-cost activity and fitness trackers, and developed devices with more moderate specs and lower MSRP as a result," notes Lemieux.

## Personal Monitors

Wearable devices are capable of gathering an incredible amount of data about a person, due to sensors embedded in the device. For example, you'll find capabilities to monitor sleep patterns, heart rate, weight, running cadence, and posture, just to name a few. If it's possible for a digital sensor to detect, a wearable device can monitor it for you.

As we stated previously, health and activity trackers are among the more popular forms of wearable technology to date, and there's a good reason: Health monitors provide a clear value. "The key unique selling proposition for wearables

The Moto 360 looks like a conventional watch, though it's plenty smart, too.

and manufacturers have been upgrading their products quickly and regularly."

Hearables are a wearable category that introduced several innovative devices in 2015. "[Hearables] are small, subtle, and built on an existing use case (music and Bluetooth headset), and the ear is a good position from which to measure the body's vital signs," says Nick Spencer, ABI Research senior practice director.

## Still Under Development

Smart eyewear, on the flipside, is a type of wearable category that's enjoyed

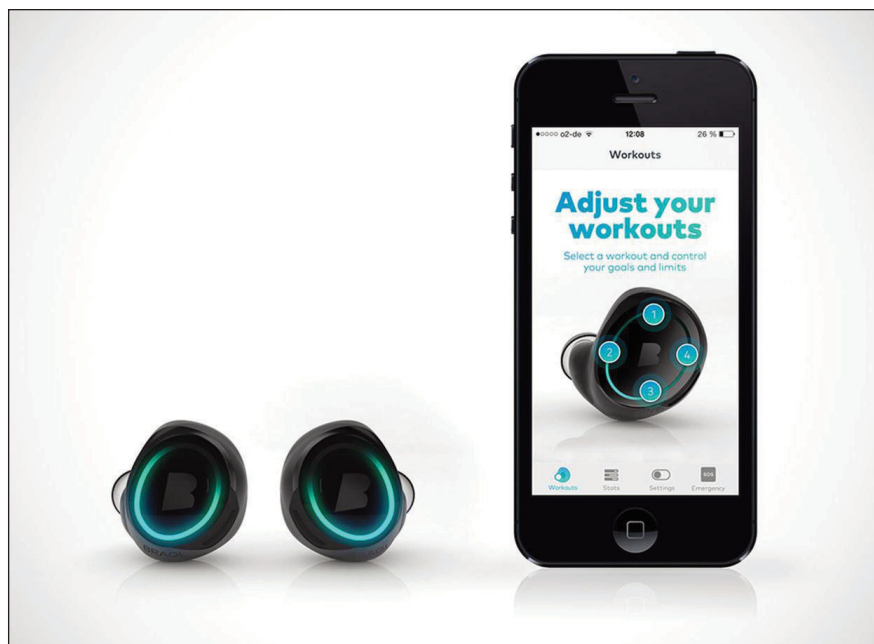
a lot of fanfare but struggled to gain a meaningful foothold among consumers. "What we are observing firsthand is a market at the very beginning of a growth phase," says Lemieux. "Google Glass, a notable, frequently hyped example among these technologies, is not remotely a mass-market product." In late January, Google shut down its Glass Explorer program that allowed consumers and developers to test it out. Google Glass will now be part of the company's Glass At Work program, and there's no word on what future Glass products might look like.



is using sensors on the body to measure someone's health, fitness, and activity," Spencer explains. The Pebble Steel, for instance, comes with a 3D accelerometer, compass, and light sensor. When paired with task-specific app, you can track runs, walks, bike trips, swimming laps, and lift reps, among a variety of other movement-related tasks. There are over 4,000 apps in the Pebble appstore, so you're likely to find something to track your preferred activities.

The Moto 360 is another good example of an attractive smartwatch with plenty of activity tracking capabilities. It has the look of a conventional watch, while still boasting the ability to record heart rate, steps and distance, and calories burned. Similar to many other smartwatches, the Moto 360 responds to voice control, so you can send texts, check weather, or ask for directions without pulling out your phone. You can also receive notifications, traffic and flight alerts, and other updates.

Health monitors come in many forms. For example, Bragi's Dash (aka The Dash) is a smart earpiece that can track pace, steps, cadence,



The Dash from Bragi is a headphone that can track pace, steps, cadence, and distance.

and distance, as well as measure your heart rate, oxygen saturation, and energy spent. And while it's doing so, you'll also be able to listen to your favorite tracks—either directly from The Dash itself (which has 4GB of

internal storage) or playback from your mobile device. The Cosinuss C-SP01 is another headphone that provides you with real-time health data. It can track heart rate and heart rate variability, as well as core body temperature.

## Android Wear

One of the key elements of a wearable device is the interface, as manufacturers must streamline the experience for minimal input controls. The interface is especially important for smartwatches, as their appeal is that you won't need to pull out your phone to get things done. Android Wear is a mobile version of Google's Android OS that's designed to connect your smartwatch and Android smartphone, so your smartphone can stay safely tucked away.

The tagline for Android's wearable-specific OS is "Information that moves with you." It all starts with the "OK, Google" voice prompt. You can call up actionable information, such as traffic and weather alerts, or tell your smartwatch to send a text message or call a friend. Google Now notifications are a good example of handy Android Wear capabilities. Google Now scans information on your Google account (such as calendar entries and your current location) to recommend action. For instance, Google Now could send a text message that tells you to leave the office a bit early to beat traffic and make an upcoming appointment.

Third-party developers sell apps on the Android Wear store, too. This way, your favorite apps can utilize the specialized sensors, services (such as GPS) on your smartwatch. There aren't nearly as many apps for Android Wear as the Android OS, but you'll still be able to select among hundreds of third-party options. Some of the most recent additions to Android Wear include Gett (a taxi-booking app), Stocard (an app for loyalty and payment cards), and FlickKey (a touch-typing app).





Samsung's Gear VR delivers a virtual reality experience for the Samsung Note 4.



The VR for G3 works with LG's G3 for smartphone-powered virtual reality.

an in-house production studio that will create movies and share processes for VR storytelling. Story Studio released its first interactive short film, called "Lost," which was shown at Sundance 2015. Oculus has stated that five more interactive experiences are in the hopper, including "Bullfighter," where you'll be in the ring with an ill-tempered bull, and "Dear Angelica," which immerses you in the pages of a comic book.

Some big players are entering the virtual reality space. "A lot of investors are being drawn to the head-mounted VR side of wearable devices, which has a lot of prospects," says Lemieux. Samsung recently released its Gear VR that's powered by Oculus but designed for use with mobile phones. Currently, it's only compatible with Samsung's Galaxy Note 4, which features an Oculus app that lets you load up virtual reality videos, movies, and photos. A touchpad on the side of headset lets control the app directly from the headset.

If you're looking for an affordable way to test virtual reality apps, check out LG's G3. In select markets, LG will be giving a VR For G3 HMD along with the purchase of a new LG G3. The VR For G3 uses the video and sound from the LG G3 smartphone, and there's a neodymium ring magnet on the side of the VR for G3 that utilizes the G3's gyroscope sensor to let you scroll through and select menu items. LG says that you can use VR For G3 with VR-compatible apps and games from the Google Play store.

As virtual reality displays mature, you might begin to see wearable devices designed to train people. "Head-mounted VR will also prove a critical asset in job training for mechanics, engineers, surgeons, electricians, and countless other trades," says Lemieux. Imagine learning highly technical skills in the comfort of your own home. Upcoming VR capabilities for hand and finger tracking will help to further promote job training.

### Smart Clothing

Until recently, monitoring vitals often meant using dedicated and sometimes

### Virtual Reality

There are a lot intriguing innovations with HMDs (head-mounted displays). You're likely familiar with the Oculus Rift, a virtual reality headset that tracks head movements to create a feedback-driven display. At this year's CES, Oculus

announced its Oculus Rift Crescent Bay prototype and Oculus Audio SDK with HRTF (head-related transfer function). The latter hopes to add 3D spatial sound to the movement tracking.

To help generate content for its HMD, Oculus launched Story Studio,



bulky devices, such as a heart-rate strap and blood pressure monitors. Smart clothing is an emerging field, with sensors in shirts, socks, and other clothing, so your apparel can collect and analyze data from your body in real time. And if all of the sensors are embedded into your clothing, you wouldn't necessarily require a separate device to monitor your biometric data.

"A number of smart clothing vendors showed significant progress at CES," says Spencer. Popular athletic brands are starting to join the party, too. Recently, HTC announced a partnership with Under Armour to develop products for the latter's UA Record platform of connected fitness clothing. Under Armour has also brought some of today's widely used tracking apps under its own roof, as it recently acquired Endomondo (an app that can map, record, and share workouts) and MyFitnessPal (provides nutritional information and help to maintain fitness goals).

Cityzen Sciences is a company that's working on shirts and other clothing that can monitor movement, heart rate, speed, breathing patterns, altitude, and GPS location. Titled the D-Shirt, it's made with Smart Sensing fabric that woven with a host of micro sensors. A detachable transmitter on the shirt pairs with your smartphone via Bluetooth. With the help of an app, your smartphone can analyze the data and provide you with calories burned, route, and other information. Besides sports applications, the D-Shirt (and other clothing like it) might be useful for people with chronic diseases or illnesses, helping limit risk factors through constant monitoring.

Another intriguing new option is the FitLinx AmpStrip. This little device sticks to your torso like a band aid and automatically tracks heart rate, respiration, skin temperature, posture, sleep, and steps, among others. The AmpStrip is designed to make heart-rate monitors more comfortable, so you won't need to wear a strap across your chest. It's also waterproof, so you can wear it in the pool and while you're perspiring.

## IoT Integration

In the January 2015 issue of Computer Power User, we took a look into the evolution of the Internet of Things and how it will impact our future. Wearable device integration could be a key driver of IoT capabilities. For example, a wearable device could signal when you leave the house, automatically turning off the lights and locking the door. And on your way home, the wearable could detect when you're near and adjust the thermostat to ensure the house is comfortable when you return.

A good example of IoT integration is the Misfit Flash, a wrist fitness tracker that also works with select Nest, Spotify, IFTTT (If This Then That), Yo, and Logitech devices. Misfit is partnering with Nest to use the Misfit Flash's sleep tracking and smart alarm functions with the Nest Learning Thermostat, so it'll only bring the house up to your preferred temperature when it detects you're waking up. Owners of a Logitech Harmony can use the Misfit Flash to control the home theater with one-touch activity option, such as Watch A Movie, Play Games, or Listen To Music. Those with an August Smart Lock can use the Misfit Flash to unlock a connected door.

In the future, you might also be able to make payments via smart clothing. International financial services provider Barclaycard has tested gloves that let you tap and pay on contactless terminals. The gloves were embedded with a contactless chip that consumers could link to a credit or debit card. At the time of this writing, there was no confirmation whether the prototype will be mass produced.

Looking for some a winter wearable? Microsoft Research recently presented a prototype for a smart scarf, dubbed project SWARM (Sensing Whether Affect Requires Mediation) that can heat up and vibrate on demand. The end goal of the project is to create a garment that can provide therapy to those with disabilities and disorders, as heat and pressure can be used to reduce stress in the wearer. The heating

## Apple Watch

Expected to launch in April, the Apple Watch is designed with haptic and audio feedback for notifications. Apple has optimized communication using the watch: There's a built-in speaker and microphone, so you can take a call or transfer it to your iPhone. For messaging, you can record an audio message or dictate a text message. You can share your location, too. For fitness tracking, the Apple Watch comes with an Activity app that breaks down different types of exercise into four rings. For example, the Move ring shows how many overall calories you burned during the day, while an Exercise ring indicates the duration of brisk activity. The Apple Watch has its own accelerometer and heart rate sensor, as well as Wi-Fi and GPS connectivity. You can also use the watch with Apple Pay to make payments at retail locations that support contactless payments.



and vibrating modules can be removed or switched around, if you want to adjust the smart scarf. Eventually, the research team hopes to add cooling and music to the SWARM, to automatically adjust to changes in the wearer's mood.

## Wearable Cameras

Wearable cameras are part of an established segment that's of particular interest to specific users—thrill seekers and documentarians. "Sales of wearable cameras have gone up," says Lemieux. "GoPro in particular has shot past



The Internet of Things is getting a boost from the Misfit Flash, thanks to integration with Nest, Spotify, and Logitech.

analysts' expectations. Its success has lured other technology incumbents, such as Sony and Panasonic, into the market. Because video content is an ever-growing component of social media, wearable 'action cameras' are flourishing concurrently."

### Buying Tips

When comparing wearable devices, we suggest a trial run before making a purchase, if possible. "The quality of the sensors, and therefore data, is still variable, so consumers need to test out how well they are recording their data," says Spencer. Lemieux adds that you'll want to check that the device "is sturdy,

durable, and comfortable, since a number of these devices are intended for long periods of wear."

Ideally, the wearable device you choose should be from a well-known manufacturer, because you'll want the company to be committed to improving the product. "Will they continue to build an ecosystem around their product, update, and continue to support technical issues?" says Lemieux. "It is a reasonable assumption that many vendors are merely dipping their toes in a trendy pool." The device's software capabilities and flexibility are important, too. Spencer points out, "Software is where the value is long-term, and

the thing that will keep you coming back for more and motivated to wear the device."

### A Wearable New World

Most manufacturers have only recently started developing wearable devices, so we have yet to see a truly game-changing device. That being said, modern sensor, screen, and processing technology can do wonders when combined with smart software and analytics. If a company can put it all together into a wearable device that provides a set of compelling functions, such as what occurred with smartphones, you might just be wearing your PC in the future. ■



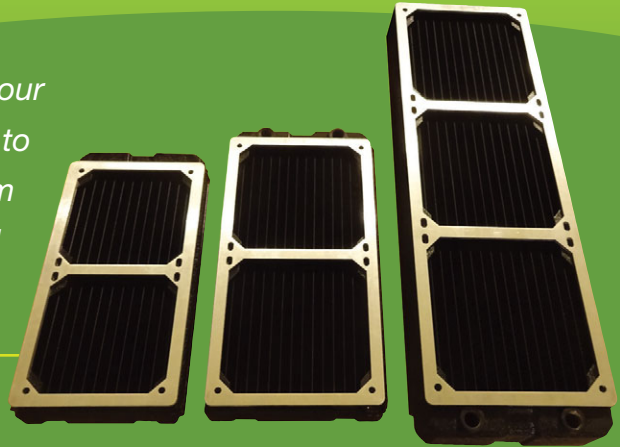


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[gmxwinterclassic.com](http://gmxwinterclassic.com)

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[www.gottacon.com](http://www.gottacon.com)

**02.27.15**

LANFest SoCal Howie's  
Gathering 2015\*

Howie's Game Shack

Mission Viejo, CA

[lanfest.intel.com](http://lanfest.intel.com)

**03.06-08.15**

PAX East\*

Boston, MA

[east.paxsite.com](http://east.paxsite.com)

**03.06-08.15**

PONG LAN: The LAN Before Time  
Menomonie, WI

[pong.uwstout.edu](http://pong.uwstout.edu)

**03.07-08.15**

LANified! 19: Running With Knives  
Calgary, AB

[www.lanified.com](http://www.lanified.com)

**03.14-15.15**

FortLAN VI

Fort Wayne, IN

[www.fortlan.org](http://www.fortlan.org)

**03.14-15.15**

BoiseLAN 1.0

Nampa, ID

[www.boiselan.net](http://www.boiselan.net)

**03.20-22.15**

SalukiLAN

Carbondale, IL

[www.salukilan.com](http://www.salukilan.com)

**03.21.15**

CEG Winter LAN 2015

Big Rapids, MI

[ceg.ferris.edu](http://ceg.ferris.edu)

**03.28-29.15**

Ultimate Gamers Showdown 2

Dauphin, MB

[www.aybonline.com](http://www.aybonline.com)

**03.28-29.15**

Naois Gaming

York, PA

[www.naoisgaming.com](http://www.naoisgaming.com)

**04.10-12.15**

Exodus LAN 2015

Troy, NY

[www.exoduslan.com](http://www.exoduslan.com)

**04.11-12.15**

AYB WonderLAN 2

Winnipeg, MB

[www.aybonline.com](http://www.aybonline.com)

**04.11.15**

Chapel Field LAN Party

Pine Bush, NY

[chapelfield.org/lanparty](http://chapelfield.org/lanparty)

**04.17-19.15**

VectorLAN 6

Portland, OR

[pdxlan.net](http://pdxlan.net)

**04.17-19.15**

AWOL LAN 25

Eau Claire, WI

[www.awollan.com](http://www.awollan.com)

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University of Wyoming Spring LAN  
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[www.uwyo.edu/infotech/lanparty](http://www.uwyo.edu/infotech/lanparty)

**04.18.15**

For LAN Sakes Let's Play  
Towanda, PA

[www.forsakenempire.com](http://www.forsakenempire.com)

**04.18-19.15**

Boilerfrag 8.0  
West Lafayette, IN  
[www.facebook.com/purduegamers](http://www.facebook.com/purduegamers)

**04.24-26.15**

SanDiegoLAN.net Spring  
LAN-A-THON 2015  
San Diego, CA

[www.sandiegolan.net/lanathon.html](http://www.sandiegolan.net/lanathon.html)

**04.25-26.15**

NeXus LAN  
Miamisburg, OH  
[www.nexuslan.org](http://www.nexuslan.org)

**05.01-02.15**

Indiana Tech Ultimate LAN Party  
Fort Wayne, IN  
[iitgamers.com](http://iitgamers.com)

**05.02-03.15**

LANified! 20: Jungle Jukes  
Calgary, AB  
[www.lanified.com](http://www.lanified.com)

**05.15-17.15**

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[www.aybonline.com](http://www.aybonline.com)

**05.16-17.15**

Parlor City LAN  
Bluffton, IN

[www.parlorcitylan.org](http://www.parlorcitylan.org)

**07.04-05.15**

LANified! 21: Summoner's Stand  
Calgary, AB

[www.lanified.com](http://www.lanified.com)

**07.17-20.15**

PDXLAN 26\*  
Portland, OR  
[pdxlan.net](http://pdxlan.net)

**07.17-19.15**

Ancient City Con 9  
Jacksonville, FL  
[www.ancientcitycon.com](http://www.ancientcitycon.com)

**07.25-26.15**

Naois Gaming  
York, PA

[www.naoisgaming.com](http://www.naoisgaming.com)

**10.30-11.01.15**

AYBOnline BaseLAN 29 @ C4  
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[www.aybonline.com](http://www.aybonline.com)

**10.31-11.01.15**

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York, PA

[www.naoisgaming.com](http://www.naoisgaming.com)

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# The Power's Back On

## Q&A With FirePower Technology

### CEO Larry Firestone

**Q : Can you tell us the story of FirePower Technology's purchase of OCZ's power supply group (including the PC Power & Cooling brand) in February 2014?**

**LF :** In December 2013, when OCZ filed for bankruptcy and Toshiba announced that they were going to acquire the assets of OCZ's SSD business, I inquired as to the status of the PSU division in Carlsbad, Calif., for which I had prior contact. When I learned that the division was not part of the Toshiba acquisition, I began to pursue an acquisition strategy. We put together a group of investors to fund the transaction, and when the PSU division was put on the auction block by the bankruptcy court, we joined the bidding and won. After we won the bid, we did not waste any time getting the business up and running again; we closed on the acquisition on Feb. 7, 2014, and opened for business on Feb. 10, 2014 as FirePower Technology.

**Q : Both brands have strong reputations and, we would imagine, longtime fans that were glad to find out that they were back. Can you tell us what the reception has been like among builders and end users who were familiar with the old brands?**

**LF :** That is correct, our fans were really happy to see FirePower continue with these brands and products. The reception has been great. When we acquired the business, we made the decision to honor the warranty for the vast installed base, and our customers have weighed in thanking us for taking care of them and giving them a secure glide path to deal with any issues that they are having.

**Q : So, along with the brand, FirePower has purchased all of the former companies' IP, correct? And aren't there**



**also former PC Power & Cooling and/or OCZ people on your management team?**

**LF :** Yes, we purchased all of the assets of the PC Power & Cooling and OCZ PSU division, but the strongest asset is the people who joined FirePower following the acquisition. This is a very dedicated team with a passion for power supplies. Most of the team has been with the company in their respective roles for more than 20 years and have an incredible grasp of the product and customer knowledge.

**Q : Your company recently celebrated the PC Power & Cooling brand's 30-year anniversary. Can you tell us about that?**

**LF :** PC Power & Cooling was formed in 1985, and the mission of the company was to solve various problems that computers were having at the time such as overheating, fan noise, and the demands of the advancing video graphics technology. Over the years, this put pressure on the

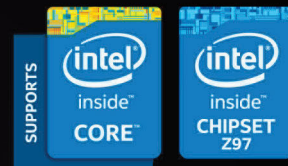
stock power supplies. Working closely with other industry architects, such as Intel, PC Power & Cooling developed CPU cooling technology that allowed companies like Intel to continue to drive Moore's law, as PC Power & Cooling allowed these chips to operate longer and more efficiently without melting down. The company carried that same mission and practice into the power supply market, focusing on high-quality, high-power, high-efficiency, and quiet power supplies. These characteristics are burned deeply in our culture, and we approach all of our products, old and new, from the same angle. Thirty years for any business is a significant achievement, and it is no less for PC Power & Cooling, as we have customers calling us who are still running our products that they put in service over 10 years ago in some very intense computing environments and are looking for next-generation technology with our commitment to quality and performance.

**Q : One question a lot of readers would love to ask you, I'm sure, is whether you intend to build and sell new FirePower Technology power supplies in addition to the existing ones? And if so, when?**

**LF :** We are currently developing next-generation power supplies for many of our markets and looking at expanding into new markets, as well. We have also engaged with our customers to design custom and semi-custom power supplies, helping them upgrade their existing product lines while maintaining backward compatibility. We will be rolling out FirePower-branded power supplies in the very near future, but we are applying the same level of quality diligence to the front end of our product launch process to make sure we and our customers enjoy the same level of success that we have had in the past. ■



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